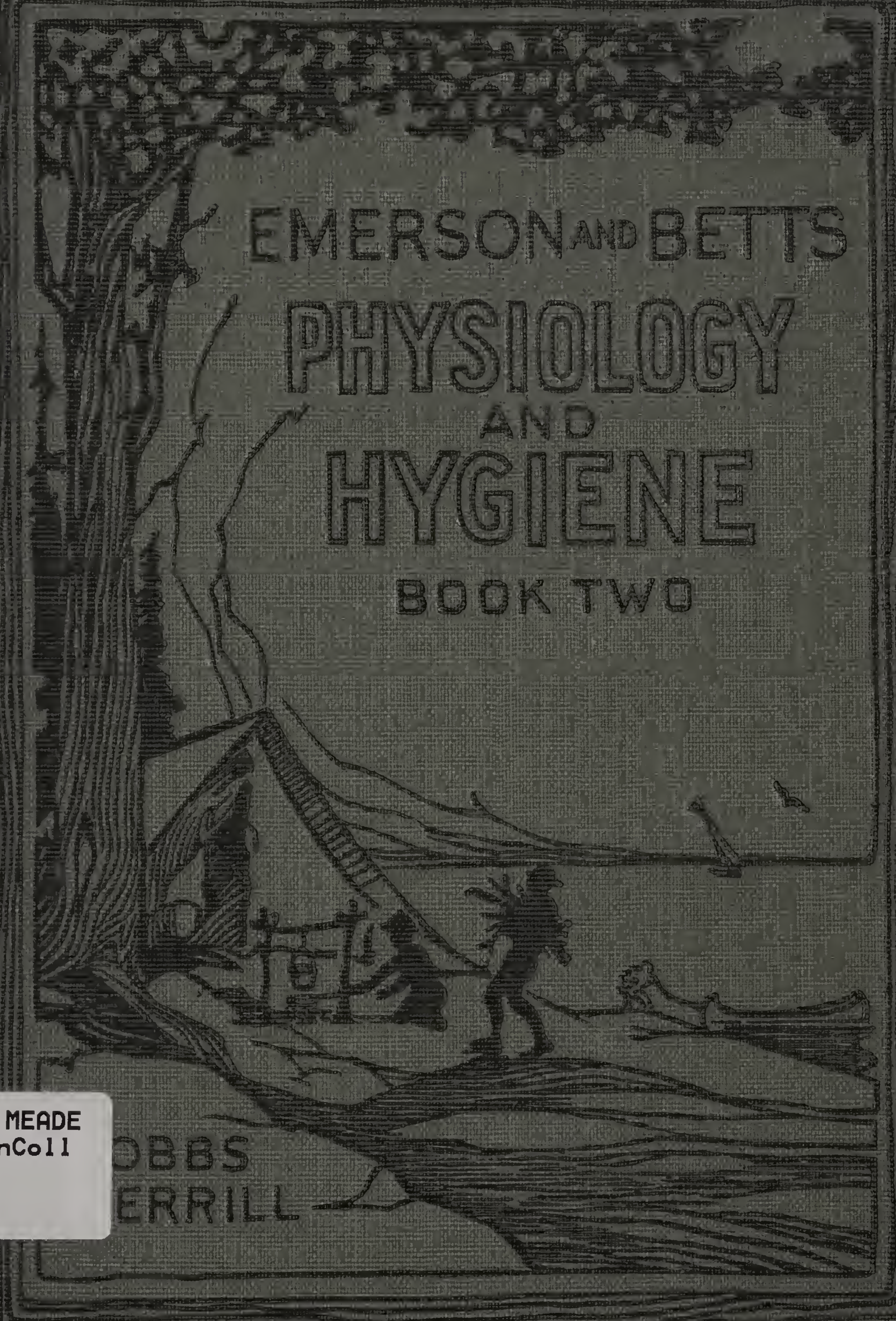
EMERSON AND BETTS

PHYSIOLOGY AND HYGIENE

BOOK TWO



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PHYSIOLOGY AND HYGIENE

A modern fairy developing grace, beauty and health

HYGIENE AND HEALTH SERIES

Physiology and Hygiene

BOOK TWO

By

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INTRODUCTION

The dominant aim of this volume, as of Book One of Hygiene and Health, is to make the instruction *carry immediately over into practise.* Many important facts and principles are presented, but never as an end in themselves. At every point the plans are laid and lessons organized to make it easy for pupils to live the hygienic truths learned and for teachers to help them secure this result.

It follows from this statement that emphasis on *hygiene* is strong in the present text, as it was in Book One. In this volume, however, the hygienic element is more definitely related to physiological function and to anatomical structure in order that the pupil may more fully understand the laws and principles which govern right physical living.

An attempt has been made to approach each topic on the plane of the pupil's interests and physical needs. Scientific truths are stated in simple language without technicalities. The exercises and problems assigned are adapted to the age and understanding. The experiments suggested and investigations asked for are such as can be carried out in any school or home. The applications made are definite and practical and have a direct bearing on health and growth. The whole treatment seeks to stimulate interest and pride in clean, well-formed, healthy bodies, trained to skilful uses.

Teachers will appreciate the effort to make the text *teachable* as well as learnable. Points of major importance are set out by numbered and indented paragraphs, or by other devices which make clear assignment easy and careful testing of results possible. Besides the thought problems and simple experiments found in connection with nearly every lesson, questions are appended to each chapter on the facts contained in the text of the chapter.

This volume will have accomplished its purpose if it in some degree helps advance the effort to make our schools an effective instrument for raising the general level of health and increasing the physical efficiency of our people.

The Authors.

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THE AUTHORS.

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PHYSIOLOGY AND HYGIENE

DAILY HEALTH GUIDE

Morning

Glass of water—Toilet

Breakfast

Fruit, cereals and plenty of milk, eggs, bread and butter.
No coffee or tea at any meals.
Eat slowly, walk to school. (Don't run.)

School

GOING *and* COMING

Take ten deep breaths slowly, shoulders straight and head up.
Don't sneeze near another person.
Use your handkerchief. *Don't spit.*

Noon

Wash your hands and face; use soap.
Glass of water before eating.

Dinner

Besides meat and potatoes, or rice, eat plenty of vegetables and only plain puddings or fruits. Chew each mouthful thoroughly.

Afternoon

Walk slowly after eating. Keep cheerful.
Play out-of-doors after school.

Evening

Wash face and hands. Glass of water.

Supper

Plenty of milk and fruits and fish or eggs instead of meat. Fried foods are hard to digest.

Windows Open

Top and bottom.

SLEEP OUT-OF-DOORS WHEN YOU CAN.

Reduced from Chart. 22-28. Issued by the National Tuberculosis Ass'n., 381 4th Ave., New York

PHYSIOLOGY AND HYGIENE

CHAPTER I

THE BODY IN ACTION

Did you ever time yourself for a sixty-yard dash? Or test how many times you can chin on the bar? Or how far you can jump from a standing start?

These are important questions for boys in the schools of many towns and cities which have school athletic leagues; for those who can make a certain record, providing their school work is satisfactory and their physical posture good, are given a badge from the Athletic League.

School athletic records.—This is the record for seventh and eighth grade boys that will win a bronze badge in some of the leagues:

60-yard dash .... 8 3/5 seconds
Chinning on the bar .... 4 times
Standing broad jump .... 5 feet 9 inches

The boy who can make a still better record wins a bronze silver badge. For the bronze silver badge, this is the record that he must make:

60-yard dash indoors.........	8 seconds
100-yard dash outdoors......	14 seconds
Chinning on the bar.........	6 times
Standing broad jump........	6 feet 6 inches

Girls also have contests in walking, swimming, basketball, relay races and folk-dancing. Girls may

Start of one-hundred-yard dash

win honors in these lines the same as the boys in their contests.

Of course it is a high honor to win a badge for physical strength and skill. Every sensible person desires a strong, well-built body, and we also want our bodies to show skill in action.

Success depends on skill.—All the world's work and achievement, as well as its play, depend on some form of action. I recently watched a girl writing

in a typewriter speed contest. The record showed that she was able to make about fifteen separate movements each second with all of the fingers of both hands. She received a valuable prize in the contest, and she also earns a fine salary. No matter whether we work in factory, mine, shop or office, our bodies must be

Learning muscular control and grace of carriage and movement

capable of moving quickly, skilfully, and easily, to perform whatever tasks we require of them.

The "master-tissues."—All the body's movements of every kind are brought about by the muscles. Muscles and nerves have been called the master-tissues. This is because of the important work they perform, and also because most of the other tissues of the body work to support the muscles and nerves.

Each of us has more than five hundred different

muscles in his body. Some are large and some are small, but scientists have studied every one, and given each its own separate name. We may be glad that it is not important that we should commit all of these names to memory.


The tendons and muscles of the back of the hand

The muscles taken together make up what we call the flesh of the body. When we buy beef-steak or any lean meat at the market we are buying muscles. If you weigh eighty pounds you have altogether about forty pounds of muscle in your body; for your muscles make up about one-half of your entire weight.

The part of the tendons.—Muscles are attached to bones by means of tendons. A tendon is a very strong, whitish, inelastic cord. You can easily see the tendons underneath the skin in the back of the hand, and feel them as they work.

The tendons are smaller than the muscles to which they are attached. This makes them better able to work over joints and at other places, as the hand or the foot, where muscles would be too large and clumsy.

How muscles produce movement.—The muscles are elastic; they can contract and expand like a piece of rubber. When the muscle at the front of your upper arm (called the biceps) contracts it bends the

The high jump

elbow joint and draws the hand up toward the shoulder. The bones serve as levers for the muscles to act upon.

Grasp the biceps of your right arm with the other hand while you bend your arm as sharply as you can. Feel the muscle swell up and become larger around as it grows shorter. Have some one measure the girth of your arm when it is extended and again when you have it tightly bent. The difference in circumference

represents the increased thickness of your biceps when it is shortened by contraction.

Pairs of muscles.—An interesting thing about the muscles is that most of them work in pairs. When you bend the forearm up toward the shoulder you find the biceps in the front of the arm growing large because it is shortened. When you straighten the arm out again, if you feel the muscles at the back of the arm you will find them growing larger as they pull the arm straight. Muscles which flex (or bend) our joints are called *flexors*. Those which straighten the joint out are called *extensors*.

Muscles which we can control.—Most of our muscles are under the control of our wills. That is, we can make them act or be still as we please. We can move the arm or keep it quiet. We can say to the muscles of our legs, "Now make me walk," and they carry out our orders; we can say to the muscles of our arm, "Now strike," and the blow comes. Muscles that we can control in this way are called *voluntary* muscles.

Other muscles which we can not control.—There is another class of muscles, however, that we can not control by our wills. Such a muscle is the heart. Suppose you try to make your heart stop beating by thinking about it. Suppose you say, "I will make my heart beat faster just by choosing that it shall." You

soon find that you are unable to control the beating of your heart. Your heart goes on in the same fashion no matter whether you will that it shall beat faster or slower; its muscle is *involuntary*.

The muscle which makes up the greater part of the stomach and food canal is also involuntary. It will not obey our commands. In the same way the muscles in our arteries and veins take care of themselves and go on doing their work day and night no matter whether we are thinking about them or not.

We may say in general that the muscles that cause movements which are always about the same, as the beating of the heart, or the action of the stomach, are involuntary; they go on acting without any attention or direction. On the other hand, muscles which cause movements that must be done quite differently at different times, such as the movements of the arms, legs, or many other parts of the body, are voluntary; these muscles move as we direct them to move, or remain still when we choose.

The structure of a voluntary muscle.—You can easily understand the structure of a muscle, or how it is made, if you will take a piece of lean beef that has been boiled until it begins to fall apart. You will notice that the muscle separates into small strands, and that there seems to be a very thin, almost transparent tissue wrapping around these various little strands.

Now if you will take a needle or some other sharp pointed instrument, you can still further separate these little bundles into smaller fibers. This picking them to pieces is called "teasing" them. If you are careful and use a microscope you can keep on teasing the bundles out until you have found very small fibers indeed. In fact these fibers are so small that it would take five hundred of them laid down side by side close together to make one inch.

We may think, therefore, of the voluntary muscle as made up of bundles of very small fibers wrapped around by thin tissue and then more bundles laid side by side with these until the entire muscle is finally formed in this way. The heart muscle is made up of shorter fibers wrapped up in bundles, while the muscle of the arteries, veins, stomach and food canal consists of tiny short fibers arranged, not in bundles, but in sheets.

Interesting experiments.—1. Show how muscles work in pairs, one bending a joint and the other straightening it again. You can illustrate by using the muscles of the arms, legs, neck, hips, etc. How many pairs of antagonistic muscles can you locate? Remember that a muscle which bends a joint is called a flexor muscle and one that extends a joint, or straightens it out, is called an extensor muscle.

2. Boil a piece of muscle until it begins to separate

into bundles. Then take two needles and fasten them in round pieces of wood somewhat larger than matches. Use these instruments to tease the separate strands apart to show the smallest

Chinning the bar placed in a school-room door

fibers you can discover. Show also the thin wrapping tissues that cover the bundles of fibers.

3. Notice the difference in the movements of a skilful piano player and one who is just learn-

ing; of a baseball player throwing a ball, and a girl throwing it; of a soldier or other person of good carriage walking, and a slouchy, "loose-jointed" person walking. What other illustrations can you suggest? Explain how one gets skill in the use of his muscles.

Questions to answer.—What are the usual school Athletic League's requirements for a bronze badge, or a bronze silver badge? Why should one develop muscular skill? What are the "master-tissues" of the body? Why are they so called? What are the tendons for, and where are they found? How do muscles act to produce movements? What do we call the muscles we control? What do we call the muscles we can not control? Of what is a muscle composed? How may we go about it to examine the muscle fibers in a piece of lean meat?

Health Problems

1. Would you rather be in the winner or the loser group in the contests pictured in this lesson? What factors will do most to determine which group you must join?
2. Do you know persons who seem to have headache or toothache or earache or something else the matter with them a good deal of the time? How may one escape these ills?
3. Thousands of dollars are spent by cities and schools upon playgrounds for children. Why is this done? What should the children do in return?

CHAPTER II

THE MUSCLES AT WORK

When you have chicken for dinner, which piece do you prefer, a part of the breast, a leg or a wing? No matter which piece you take, you eat muscles. Yet the taste is very different, and while the muscle of the breast or wing is tender, that of the leg may be rather tough.

You have had beef-steak that was tender and easily chewed. Another time you may have had a piece so tough that it took all the strength of your jaws and all of your patience to masticate it.

What is it that makes one piece of muscle tender and another tough when we come to eat it?

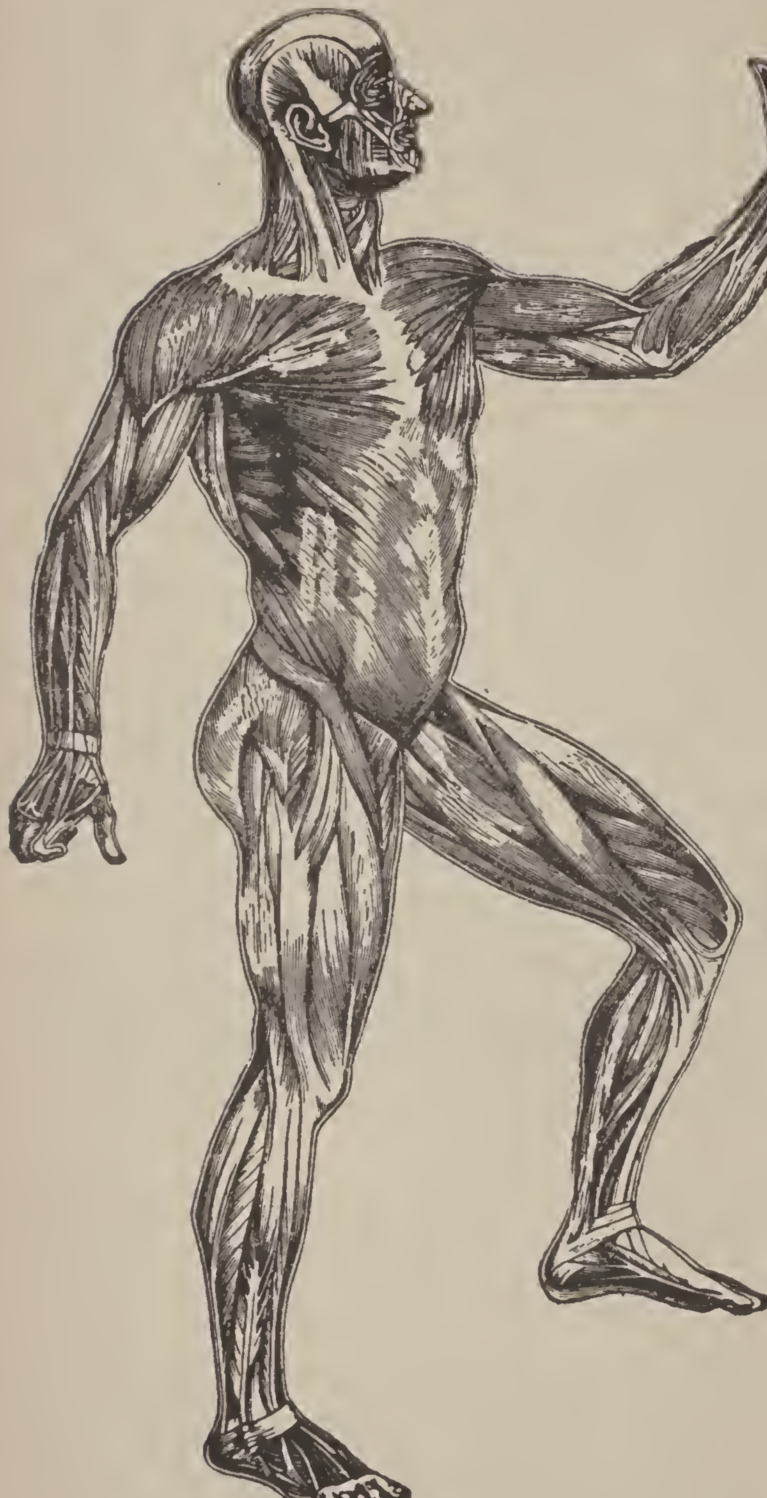
How muscles grow firm and strong.—In order to answer this question, we shall need to refer again to the muscle fibers and the way they are wrapped together in bundles. Each of these tiny fibers is wrapped in its own little sheath, called by the hard name *sarcolemma* (sȧr cō lĕm′ ma), and each of the bundles of fibers is also enclosed in its own separate wrapper, while several of these bundles are bound up

into still larger bundles by still coarser wrappers. These wrappers which enclose the bundles of fibers are not like the sarcolemma,—the sheath of one single fiber, but consist of another kind of tissue called *connective* tissue. It is found in all parts of the body, binding all the various parts of organs together and strengthening and protecting them. It threads in and out among all of the bundles of muscle fibers, binding them together and helping to give them their rigidity and shape.

Now there are two things that will make these tissues grow hard and tough. One is age. The young chicken or turkey is tender because its connective tissue has not yet thickened and hardened. The old fowl is tough because this tissue has grown dense and hard.

The other thing that will cause muscle to grow hard and tough is exercise. The breast or wing of the chicken is more tender than the leg because the muscles of the chicken's breast and wing have but little exercise, while those of the legs are constantly used. The law therefore is that muscles grow hard and tough with age and with use.

When muscles are not used.—You can easily test this difference by feeling of the muscles of a child's arm and then testing the muscles of the arm of a blacksmith or some other person who labors with his arms.



The way the muscles would look without their covering of skin and fat

Nobody wants muscles that are flabby and weak from lack of exercise. We want our muscles hard, firm and tough. And we may depend upon it that our muscles will not possess strength and endurance unless they are constantly used and hardened to their work.

Training the muscles of the face.—An important fact about muscles is the ease with which they are trained. Suppose you now stop and think of some person whose face usually looks solemn, sour, and unpleasant. Of course he may smile now and then, but the habit of his expression is to be glum. On the

other hand, think also of some friend whose face is cheerful, happy, and bright, and who instead of a frown, usually has a smile hovering about his mouth and eyes.

The expression of our faces is caused by the muscles which lie just underneath the skin of the face. If these muscles have been trained to pull the face into a sour expression, if they are accustomed to turn the corners of the mouth down, and make a frown between the eyes, then they soon keep this form of expression. We then have the habit of a sour expression. If, on the other hand, the facial muscles have been trained to smile, if they have been made to turn the corners of the mouth up in place of down, then they easily take this position and give us a bright and cheerful expression. It is all a matter of habit. The muscles easily settle into the form in which they are commonly used.

Muscles that keep the body straight.—This same law is seen in the way men carry their shoulders. If you look out upon the street as men are going to their work, you will see that some have stooped, bent shoulders, and that others carry themselves upright, with shoulders straight and head up. Some stoop because of illness, but the most of these men with bent shoulders are the ones who have got into the habit of stooping as they work, and their muscles have settled into the shape in which they are con-

stantly used. The men who carry themselves erect are the ones who have trained their back and shoulder muscles to hold the body erect as they work; and their muscles have come to take the form which keeps the body straight and in good posture. Have you not been surprised at the great difference a few weeks of

It is easy to see where the winning athletes and strong healthy men are to come from

training in the army have made in some of your friends? When they went to camp they slouched along as they walked, but now they stand erect, and with what a beautiful gait they walk!

It is important to remember that *muscles finally come to take the form in which they are most commonly used.*

With this law in mind see whether you can answer the following questions:

1. Are any of the pupils in your school room training their muscles in such a way that they will come to have stooped shoulders and hollow chests?
2. Are there any who, because they generally have an unpleasant expression of the face, are training their face muscles into undesirable habits?
3. Do you know people outside of the school who, through wrong postures when at their work, have so trained their muscles that their bodies are no longer well shaped? Do you know other people who have so trained their muscles that their bodies are as straight and erect as when they were young?
4. Are you allowing any of your muscles to develop undesirable habits?

Good muscle habits to form.—1. Make the muscles of the back and shoulders keep the body erect, the shoulders back, and the head up. This will not only give you a good carriage, but will keep you from becoming stoop-shouldered, hollow in the chest and of bad form in general.

2. Train the muscles used in walking to give you a firm, even step, such as shows decision of character, rather than to allow a careless, shambling gait, which is always unattractive.

3. Train the muscles of the face to smile instead of to frown. Do not allow them to twitch, grimace, or to acquire any other mannerism which is undesirable.
4. Train the muscles of speech to bring out each sound clearly and distinctly, not mumbling words nor cutting off sounds at the ends of words as people often do when they say *an'* for *and* or *goin'* for *going*.


Muscles of the leg

Questions to answer.—What is the tissue called which is found wrapped around bundles of muscle fibers? What is connective tissue and where is it found? What is it that makes some lean meat tough while other meat is tender? How can we make our muscles firm and strong? Explain how the muscles of the face act to give us different expressions. How may we train our face muscles so that we may have a pleasant look rather than a sour one? Why do some persons have stooped shoulders while others are straight and erect? What are some muscle habits good to form?

CHAPTER III

TRAINING THE MUSCLES

Suppose the boys who read this lesson would like to increase the size of their biceps. Suppose the girls would like to cure themselves of drooping shoulders and hollow chests. What can be done about it? Can we change the size and habit of our muscles? Can we make them do the work we demand of them? Can we change awkward and unskilful muscles into muscles that are well controlled?

We can. It is comforting to know that muscles which so easily allow our shoulders and back to take wrong shapes and positions can just as easily be trained to make them take right ones; and that acts and movements which are awkward and bungling can be changed into well controlled, skilful ones.

Developing muscles through use.—Just to show how muscles will respond to training: Among my friends is a blacksmith, who is large of build and very strong. He works with both arms, of course, but he works most with his right arm. All day long he keeps his right biceps busy as he hammers the iron on his anvil. I recently asked him to let me measure the

girth of each of his arms with the biceps drawn up to full size. His left arm showed a circumference of sixteen inches, but his right arm measured nineteen inches.

This difference in size in the blacksmith's arms had

Everybody works at the Boy Scouts' camp

been caused by years of labor in which the right arm had been called upon for more work than the left arm. Whatever muscle is exercised, that muscle demands a larger supply of blood. The blood brings to the muscle additional food material. The muscle uses this food supply to increase its size, and so grows larger and stronger.

It has been proved many times by actual experiment that through proper exercise of the muscles a man of average size can increase the girth of his arm around the biceps as much as three-quarters of an inch in four or five weeks.

Muscle training and good posture.—The muscles of the chest and shoulders can be trained in the same way. There is no great trouble in increasing the girth of the chest by an inch or two in a few months' practise. It is all a question of proper exercise of the muscles. With careful attention given to full, deep breathing, and with erect carriage of the chest and shoulders the muscles will increase in size and strength.

In similar fashion we can develop the large muscles of the back, which carry the shoulders and hold them in position. If we allow the muscles to become slack and the shoulders to sag, the muscles grow weak and flabby. On the other hand, if we make the muscles of the back do their work, if we give them exercise by requiring them to hold the shoulders straight and the body erect, then these muscles develop in size and strength so that they naturally and easily hold the body in good posture.

Muscles quickly respond to training, both in size and strength. A muscle soon comes to take the shape or form in which it does its work. It develops whatever of strength is demanded by the work it has to perform.

Training our muscles to skill.—Muscles must also be trained in skill. No one wants to be awkward or clumsy in his movements. No one wants to be a slow or bungling workman.

I have a schoolboy friend who has practised until he can toss a number of small balls, keeping two in the air at one time. He is now working to see whether he can not keep three balls in the air. I have another friend who is working hard to gain skill on the typewriter keyboard, so that he may become an expert typist and so secure a good position. He also desires to enter a typewriting contest soon to be held to see whether he can not win a prize. They are both seeking muscular skill through careful practise and training of their muscles.

All of us are, of course, seeking to train our muscles to skill in many directions. We wish to learn to write a good, legible hand with fair speed. We would like to play the piano or violin; or we are seeking to perfect ourselves in the handling of a tennis racket or a baseball bat. If not any of these things, then we are surely at work in a score of other directions trying to win skill for ourselves in our play or in our work.

The value of skill.—And this is all as it should be. No one likes the bungler. Every one should be ashamed of awkwardness which could be overcome by greater care and practise. The workman who does not attain both skill and speed never secures the higher salary,

and never is certain of his job. The highest pay and the highest honors, whether in work or in play, always go to the person who has learned to control his muscles, and who has made them the most serviceable in carrying out his will.

Learning skill and developing muscle at the same time

The boy who is learning to toss the balls has been working hard at it for a number of months. Season after season boys and girls play at different games, perfecting their skill in them. Year after year men work at their trades, developing both skill and speed, and finally become expert workmen. Through intelligent practise is the only way we can train our muscles to high skill.

This, then, is the law of our muscle training: Skill comes only through well directed, faithful and continued practise. We must not aim simply at improving a little. We should never be satisfied with the skill we have already reached, but must always be aiming at something better. We should never say, Oh, that is good enough! We must rather say, No piece of work or act of skill is good enough until it is the best that we can make it!

Facts worth remembering.—1. Our muscles must be trained. Strength and skill do not come by chance; we must work for them. Harry Houdini, one of the world's greatest magicians, tells how he is able to perform feats no other man can do. He says:

"No one except myself can appreciate how I have to work at this job every single day, never letting up for a moment. In each town where I play I hire an empty stable, or loft, or room, and here I put in hours upon hours of study and experiment." Even this great master of his art must practise daily to keep up his skill.

2. Nothing worth while is easy. If we would stand well, walk well, write well, play well, or work skilfully we must give the time and effort necessary to train our muscles to their work. We can not stand awkwardly, slouch as we walk, write carelessly, play poorly, or work below our best

without having our muscles form bad habits. We should strive to work, play, or do whatever we do always *at our best.*

Problems and experiments.—1. Test the skill of your muscles by tossing two balls, keeping one in the air all the time. Try sawing a board square across by following a scratch line.

2. Place a sheet of paper on your desk and hold a small mirror so that you can see the paper in the mirror. Now while watching in the mirror, write your name so that it will read right in the mirror. Try writing your name in this way a dozen or more times. Do you find your skill improving with practise? What lesson does this teach?

3. Which ones of your muscles do you think you particularly need to train? Think of your posture, speech, skill in work, games, etc., before deciding. Are you willing to give the care and practise necessary to train those muscles which require it?

Questions to answer.—How can we go at it to change the shape and size of different muscles? Explain the lesson taught by the difference in size of the blacksmith's two arms. Why does a muscle which is used grow larger and stronger than one which is not used? Explain how one may train the muscles of his shoulders and chest to hold his body erect. How can

the muscles be made quick and skilful for work or for games? What is the only way to gain skill? Tell the story of Houdini and explain the lesson taught by the story. Why is mirror writing so much more difficult than ordinary writing?

Health Problems

1. Make a list of games in which you have fair skill; a list of games common to your age and sex which you do not know how to play.
2. Place your open hand, palm down, on the table. Now raise and lower your index finger rather rapidly for several minutes, keeping the rest of your hand in contact with the table. What does this teach you with reference to fatigue?
3. Notice, as you are among people, what proportion of them have stooped shoulders; one shoulder lower than the other; heads bent forward; a bad gait in walking. How do they come by these peculiarities?
4. Observe your schoolmates and then describe five habits you discover which are bad for health (not mentioning names of persons); five that are good for health. How many of these ten habits have you?
5. What are you especially doing to correct any bad health habits you may have? What good health habits have you in the process of forming? How does one form habits? How does he break habits?

CHAPTER IV

THE FRAMEWORK OF THE BODY

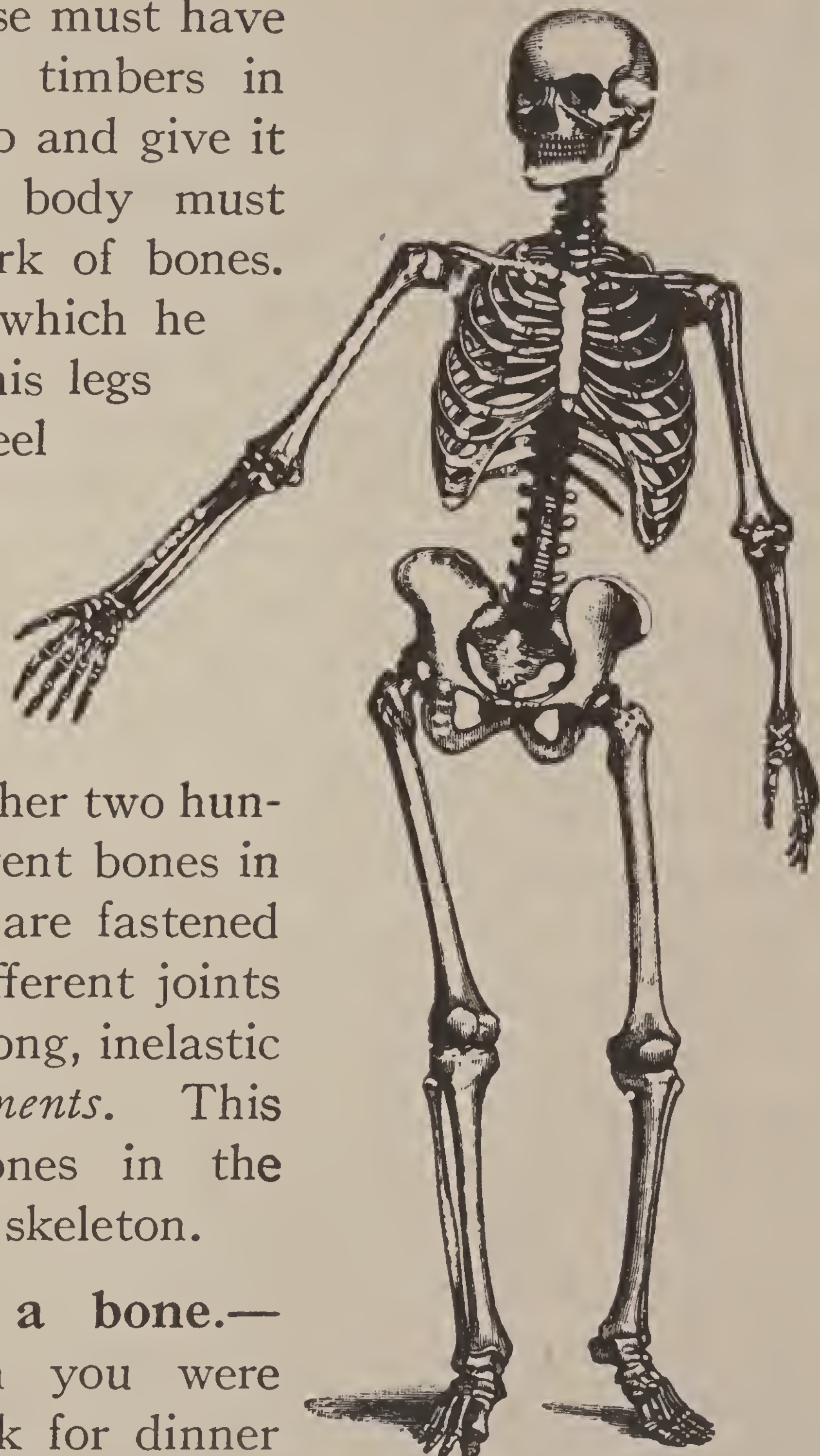
Most people have never seen one of their own bones. For our bones are all hidden away under the skin and the flesh, and one does not have very much to do with his bones unless he happens to have an accident and break one of them.

Yet the bones play a very important part in our bodies. Yesterday I saw going along the street a boy who had iron braces strapped to his legs. They had hinges at the knees which bent backward and forward as he walked. The poor fellow was having a hard time of it, for it seemed that even with these braces his legs would hardly bear him up.

Bones make the body rigid.—The trouble was that some disease had kept his bones from hardening as they should, and they were therefore unable to sustain the weight of his body. Lacking firm, rigid bones in them, his legs would bend and probably break if he undertook to stand on them without the help of the iron braces. So Jamie is a cripple because his bones do not make a strong enough framework for his body.

Just as the house must have its framework of timbers in order to hold it up and give it strength, so the body must have its framework of bones.

Jamie's braces which he had strapped to his legs were really a steel skeleton meant to take the place of the bones which had failed to do their part inside.



The bony framework of the body, called the skeleton

We have altogether two hundred and six different bones in the body. These are fastened together at the different joints by very tough, strong, inelastic bands called *ligaments*. This framework of bones in the body we call the skeleton.

Structure of a bone.— Some time when you were having round-steak for dinner you may have got the piece which contained a round piece of bone. This bone was hollow in the center. Suppose you ask for this piece next time and examine the

substance that fills the center of the bone. It is called *marrow*, and consists largely of fat, oily substance and of blood-vessels.

Most of our bones are hollow. All the hollow bones have this central tube filled with marrow.

Each bone has a covering of tough tissue called *periosteum*. If a bone has been broken or has had a piece cut out of it new bone tissue will form and the broken ends will grow firmly together if the periosteum has not been too much injured.

How bones grow.—I once saw a surgeon perform an operation which illustrates how a bone is able to repair itself through growth. A man had had the bone of his leg broken, and it did not heal properly. Instead of growing together the broken edges would slip past each other. After giving the man an anesthetic the surgeon sawed a strip out of the bone on each side of the break. He then fitted one of the pieces he had sawed out into the space so that half of its length extended on each side of the break. This piece of bone served as a key to keep the bones from slipping. The surgeon had been careful not to injure the periosteum, and the new piece of bone quickly grew fast, and the break soon healed. Pieces of bone are sometimes transplanted from other parts of the body to repair a nose or other part of the face that has had a part carried away by a shot in battle or by some accident.

The large bone of the upper leg (called the femur) cut lengthwise to show hollow structure

Bones which have been broken will soon knit and be as strong as ever if they are properly set. Soon after a bone is broken, nature causes the broken place to be filled up and surrounded by a fluid which hardens into a cartilage-like substance, and later changes into real bone. This cartilage-like substance, called *callus*, serves to hold the ends of the bone in place while they are healing, and adds strength until the injured part has fully recovered. It is this callus which causes the bone to be larger for a time at the place where it has been broken.

Differences in bones caused by age. —The baby's bones are soft and will bend easily. This is why a baby seldom breaks his arm or leg when he falls.

You have also observed that aged persons are very careful when they walk over slippery places, as if they are afraid of falling. Nature has been wise in making the aged cautious, because an old person's bones will break much more easily than a child's. If once broken the bones of an old person heal slowly as compared with the bones of a younger person.

Bones of the old and the young.—We may compare the bones of the old and the young in this way:

1. In youth our bones are softer and more easily bent. They will keep whatever shape is given them at that time. They do not break easily, and if broken will heal quickly.
2. The bones of an older person are more rigid and brittle. They will break more easily than in youth, and will not heal so quickly when broken.

Matter of which bones are composed.—It is easy to understand the cause of this difference between the bones of the young and the old if we remember that bones are made up chiefly of two kinds of material: (1) *animal matter*, which gives the bone its toughness and elasticity; (2) *mineral matter*, which gives the bone its hardness and stiffness.

When we are young there is a larger proportion of animal matter as compared with mineral matter. As we grow older the proportion changes so that there is a larger amount of mineral matter. The boy who had to wear iron braces on his legs lacked mineral matter in his bones to make them rigid. The very aged person whose bones break almost as easily as a pipe stem lacks animal matter to make them tough and elastic.

How bones may change their shape.—Perhaps you have read how, just to be in style, little Chinese girls sometimes have their feet bound up tightly when they are very young. Feet kept bound in this fashion

can not grow. They remain so tiny that girls with bound feet can hardly walk. For when the baby's bones are soft they are easily made to take whatever shape or size is forced upon them.

We do not bind the feet of our babies. We do, however, sometimes change the natural shape of our bodies in such a way as to bring on a deformity. For example, boys and girls who have the habit of sitting in a slouchy manner may when they are older never be able to walk erect.

Keeping the body straight.—We can better understand how such deformities come about if we consider a few facts about the structure of the back-bone. The spinal column or back-bone is made up of twenty-four little bones, resting one on top of the other with small pads of *cartilage* in between. Cartilage is a tough and springy substance somewhat like felt or rubber. It is what we call *gristle* when we find it in meat.

These pieces of cartilage act as elastic cushions to save the body from jolting and jarring as we walk. The pads of cartilage naturally press together somewhat from the weight of the body. The effect of this is that we are somewhat shorter at night than in the morning. While we sleep these little pads take their natural shape again, so that we are full height every morning.

It is easy to see that if we keep our backs bent forward and our shoulders stooped a great deal of the

The spinal column. Note the separate vertebrae with the thin layer of cartilage between

time the little cartilage cushions will be pinched at the front edges or on one side and made thinner at those points. If the constant pressure continues from day to day because of bad postures, the cartilage cushions finally come to keep the unnatural wedge shape, which gives us the stooped shoulders and bent backbone. As we grow older the cartilage, like the bones, hardens and can not easily be made to take its former shape.

Correcting wrong shape.—The important thing to remember is that both bones and cartilage are much more easily shaped by the pressure or strain upon them *when we are young* than when we are older. It is therefore very important that boys and girls should keep the best possible postures of the body and not allow their bodies to become bent or deformed.

As long as we are young we can do much to correct any wrong shape which the body may have taken. If our shoulders have become stooped or our spine crooked through bad postures or any other cause, we can do much to correct them. We shall

Little danger of this Girl Scout developing a curved spine or round shoulders. Note her straight carriage

need constantly to keep watch that we maintain such postures as will relieve the pressure which has caused the deformity.

Things that help.—The "setting-up" exercises of the soldier, the gymnastic drills of our school gymnasiums, and the correct, easy carriage of boys and girls who know how to control their bodies all tend to give us a good body framework.

On the other hand, all slouchiness of carriage, all wrong postures in work,—in short, all carelessness of posture when we stand or sit or walk is sure to give us a body framework that is out of true proportion.

Interesting things to do.—1. Get a piece of fresh bone at the meat-market and study the edge where it has been sawed off. Point out the canal of the bone. Show the marrow. See whether you can find blood-vessels in it. Can you see where the blood-vessels pass through holes in the bone to the inner tube? Point out the thin, tough, wrapping coat called the periosteum. Tell what makes the bone pinkish in color.

2. If your school can supply you with a bottle of *muriatic* acid, place in it the leg of a chicken, and leave for several days. Then take the bone out and wash the acid from it and show that the bone is no longer rigid and stiff, but that it is so plastic that it can even be tied in a knot. This is because the acid removes the mineral matter and leaves but the animal matter in the bone. (Remember that muriatic acid is a strong poison.)

3. Take another leg of the chicken or some other piece of bone. Place it in an iron shovel or a metal pan and burn it for half an hour or more in a hot fire. Then show that the bone is brittle and can even be crumbled between the fingers. This is because the fire has burned out the animal matter and left but the mineral matter.

Questions to answer.—What are all of the bones of the body taken together called? Explain two great uses of the bones. How many bones are there in the body? How are bones tied together at the joints? How are our muscles fastened to bones? What is the fatty substance found in the hollow of a bone called? Why are the bones of an old person more easily broken than the bones of a child? Why are the bones of a child more easily bent than the bones of an older person? Explain how bones may be made to change their shape. Explain how a stooping position as we work may give us a crooked spine or bent shoulders. How may a crooked spine or bent shoulders be corrected? Why does a bone placed in acid become soft so that you can bend it? Why does a bone which has been burned in the fire become brittle?

Health Problems

1. Although children seem to have many more falls than older persons, they less often break bones in such accidents. Explain why this is.
2. Mention a number of deformities that are caused by something being wrong with the bones.
3. Just what has happened to the bones when a person has had his neck or his back "broken"? Why is the arm more easily dislocated at the shoulder than the leg at the hip joint?
4. Give an account of any accident of which you may know which resulted in a broken bone. How long did it take the bone to heal?

CHAPTER V

JOINTS AND BODY MOVEMENTS

I once visited a hospital where I saw a man ill of some disease that made it impossible for him to turn his head, bend his knees or his elbows, or use almost any other joint of his body. I was told that the disease stiffened the joints so that he had practically no joints at all. I then understood more clearly than I ever had before just what joints are for. Without joints we could have no movement of any part of the body.

Kinds of joints.—About the best way to understand joints is to examine a number of our own. Suppose you begin by bending your finger at the first or second joint. You soon discover that you can get motion in only two directions—backward and forward like a hinge. Such joints are called *hinge joints.*

Now if you will try moving your wrist, you find that you can move it in several directions. The eight small bones in the wrist joint glide over one another and allow a wider range of movement than the hinge joint. This kind of joint is called a *gliding joint.*

Next try moving your head in as many directions as

possible. You observe at once that you can nod your head backward and forward and also turn it from side to side. This is arranged for by a special kind of joint which is called a *rotary joint.*

Now try swinging your arm from the shoulder in every direction possible. You will find that it has a very wide range of motion. In fact you can move it in more directions than any of the other joints that you have examined. The shoulder joint is of the kind called *ball and socket.* The hip also moves on a ball and socket joint.

We have other joints that are not meant to allow movement. Joints of this kind are found uniting the bones of the skull.

The knee joint, with a ligament showing at each side. Not all the ligaments are shown

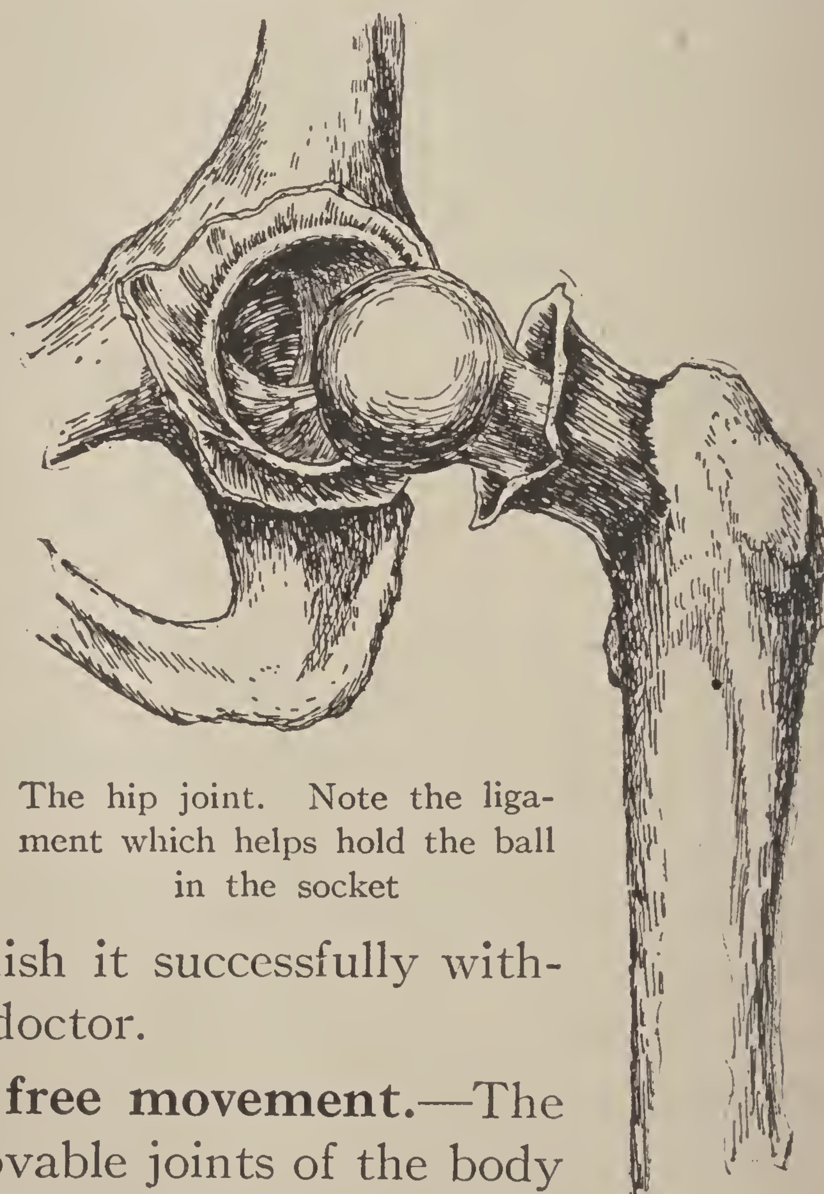
The wearing surface of joints.—In all movable joints the surface of each bone is covered with a cap of *cartilage.* This has a hard, tough, smooth surface, which allows the bones to move easily and with little friction. The membrane of the joints gives out a thick, oily fluid which serves the same purpose for the joint as the oil that we put on the machine.

The movable joints are, as we saw in the last chapter, fastened together by tough, inelastic bands called

ligaments. When these ligaments are over-strained or torn loose, we have a sprain.

The work of ligaments.—Sometimes a sudden strain or wrench upon a bone is sufficient to throw the joint out of place. This accident is commonly known as a *dislocation.* The shoulder joint which has a rather shallow socket is one of the most easily dislocated joints of the body.

When a bone is thrown out of joint or dislocated, it should be immediately put back in position. It is usually necessary to have the doctor do this, although one who understands joints may sometimes accomplish it successfully without the aid of a doctor.



The hip joint. Note the ligament which helps hold the ball in the socket

Strength with free movement.—The strongest of the movable joints of the body is the hip joint. This has a very deep socket, and is therefore not easily thrown out of joint. Since the hip joint is required to support the weight

of almost the entire body every time we step, it is easy to see why this joint must be strong and firm.

Nature has been doubly careful that the hip joint shall not be thrown out of joint. This is accomplished by tying the head of the thigh bone into the socket by stout ligaments which makes it impossible for dislocation to occur without a strain severe enough to break the bone itself.

When joints grow stiff.—When a joint is bruised and can not be used for a time, as when a bone is broken or a severe sprain has occurred, the joint may become stiff. Joints require exercise to keep them in good working order and cause the oily fluid to flow. The joints of many of the aged grow stiff and their ligaments harden because of slight chronic inflammation. The effects of these changes are easily seen in the walk and carriage of some who are old.

A painful inflammation of the joints, popularly called rheumatism, but more correctly *arthritis,* often occurs. Arthritis frequently causes the joints to swell and become stiff. It was formerly thought that this ailment was caused by living or working where it is damp. Now we know, however, that it is caused by germs. The germs get into our blood from some source of infection, such as diseased tonsils or decayed teeth. The cure for arthritis is, of course, first of all to remove the source of infection from which the germs come and then to limber up the joints by proper exercise.

Interesting things to do.—1. Locate on your own body as many of the different kinds of joints as you can, writing down a list of them under the heads: *hinge*, *ball and socket*, *gliding*, *rotary*, *immovable*.

2. Bring from the meat-market a fresh joint from the leg of a beef or a pig from which most of the meat has been removed. Show the ligaments that hold the bones in place. Test them for strength. If you can get a hip joint show the ball and socket and the loose ligament that ties the ball to the center of the socket.

3. On a fresh joint show how the wearing surface is covered with cartilage. Note how smooth the surface is. Show the oily fluid which lubricates the joint.

4. See whether you can find several of the vertebra bones of some animal. The butcher may be able to help you. Possibly the doctor could lend some of the bones from a human skeleton. Show how the vertebræ fit together. Show the canal for the spinal cord.

Questions to answer.—What are joints? What are the different kinds of joints found in the body? Tell where at least one of each kind of joint is found. Explain how bones are fastened together at the joints. What is a sprain? What is a dislocation? How are joints sometimes made stiff? What is the remedy for stiffened joints?

CHAPTER VI

THE FOOT AND ITS CARE

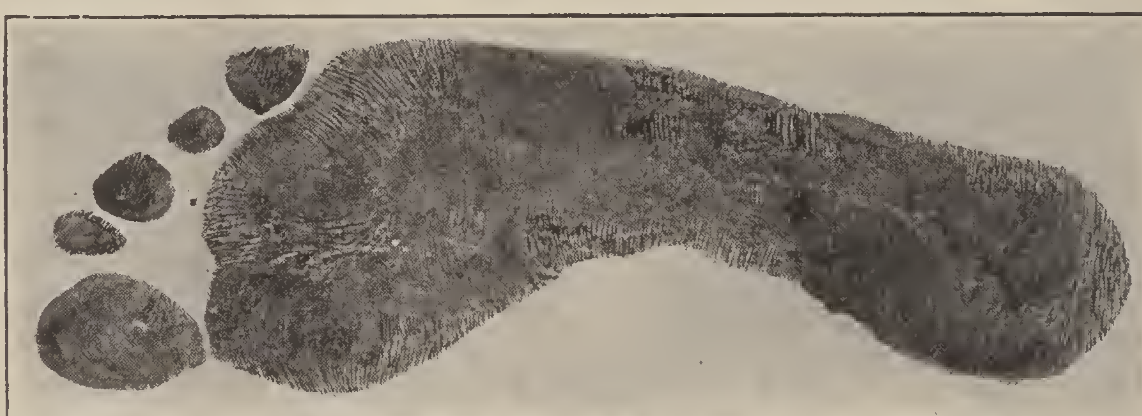
I have just been out watching some boys who are training for a track meet soon to be held at the school. Their trainer was explaining to them how to get a quick start when the signal is given. He was also showing them how to use their feet in order to get a springy, fast stride. He was urging upon the boys that one can never be a good runner if he does not have the best of feet.

The foot is made up of a wonderful combination of twenty-six bones. These bones are fastened together by large bands of ligaments, and are connected by strong tendons to the muscles of the leg.

The work of the foot.—The foot has very hard work to do. It must hold up the entire weight of the body at every step. Not only must the foot be strong, but it must be elastic and springy enough to give the body an easy, graceful carriage.

A good many people have poor feet. Their feet may be so weak as to give trouble in standing when at work. Or the feet may lack the strength and elasticity to give easy movement in walking or running.

Flat-foot, or broken arches.—One of the worst foot troubles is that called *flat-foot*, or *broken arch*. In flat-foot the muscles of the lower leg and ankle are too weak to support the weight of the body on the foot. The ankle bends inward and the inner edge of the foot helps bear the weight of the body. The springiness that comes from the arch of the instep is lost, and a heavy thumping gait is the result.



Impression left by a normal, well-shaped foot

The best test for flat-foot is to take the impression of the bare foot on a piece of paper when the sole of the foot is damp or when coated with powdered charcoal. The strong, well-shaped foot will give the marks of the toes, the ball of the foot, the outer edge of the foot and the heel, leaving a sharp circle underneath the arch. The flat foot will leave an impression on the inner edge as well as the outer.

Tests for flat-foot.—Another evidence of flat-foot is the way we wear our shoe heels. If they wear off on the inside edges rather than wearing evenly over

the entire heel, it indicates that our ankles are turning in, and that we are threatened with flat-foot. In flat-foot the toes also have a tendency to point outward as we walk.

A flat foot is always weaker than a normal foot and therefore quickly tires. A flat-footed person often finds that walking produces pains in the feet or in the legs or the back.

Impression left by a flat foot

The doctors tell us that more than one school boy and girl out of ten have flat-foot. Thousands of men have had to be rejected from our army because of flat-foot making it impossible for them to stand marching and the work of the soldier.

Wrong styles in shoes.—The easiest way to discover the cause of flat-foot is to go to a shoe store and look over the styles of shoes. Many of them have soles much narrower than the foot, and so do not give a broad enough basis to stand or walk easily. The

balance of the body must therefore be held by the muscles of the leg. These soon tire, grow weak, and allow the ankle to turn in. When this has gone on for a little time the muscles and tendons have become accustomed to the wrong position, and the first thing we know we are flat-footed. The high heels worn by girls not only weaken their feet but prevent them from having an easy, natural carriage.

The position which high heels make the foot take

The way the foot should rest in the shoe

On the whole I think we treat our feet very badly. We are shocked when we learn that the Chinese have been accustomed to binding the feet of their babies to keep them so small that they can go into tiny little shoes. The Chinese are stopping this barbarous custom, however, while we still wear shoes which are often too tight, that do not fit the shape of the foot, that have narrow soles and high heels.

The right kind of shoes.—Every boy and girl should hunt for shoes that meet the following conditions:

1. The shoe should fit comfortably, but not be so loose as to allow the foot to slide around in it.
2. The shoe should be the shape of the foot in its natural form as we stand with our weight upon it.
3. The soles should be broad enough to give a good basis upon which to balance the body's weight as we stand or walk.
4. The heels should be broad and low.

Curing weak feet.—If one finds that he has flat-foot he can do much to cure it. The growing boy and girl should not wear arch supports since these will prevent strengthening the muscles and so curing the condition. The first thing to do of course is to secure shoes that will measure up to the four rules which we have just given. The muscles of the lower leg and foot can be strengthened by rubbing and exercising them each evening as we retire.

We can strengthen the muscles also by specially planned exercises. A good method is to stand squarely on the bare feet and lift the body as high as possible on the balls of the feet. Do this as many times as you can without tiring or overstraining the muscles. Carry the exercises through each night and morning, increas-

ing the number of times the body is raised as the muscles grow stronger. Also practise morning and evening walking on the outer edges of the bare feet.

Corns.—A great many people are troubled with corns on their feet. A corn is a hardened growth in the skin which presses down on the sensitive nerves and causes much pain. Corns are caused by some unnatural pressure or rubbing.

The most common cause of corns is narrow shoes that crowd and pinch the toes, or shoes that are too loose and so rub some part of the foot.

By far the best treatment for corns is never to grow them. If a corn is once formed there is little use to try to cure it unless we remove the cause. We must therefore remove the pressure or the rubbing. If we do the corn will drop off. Get the shoes that will fit, cut a hole out over the corn, or put an insole in a shoe that is too large. If you pare a corn, be sure that the toe and the knife are clean for there is danger of infection; however, paring will not stop the growth of a corn.

Interesting problems and experiments.—

1. Let each member of the class stand with the bare foot on a sheet of paper. Have some one trace around your foot with a pencil, thus taking an impression of your foot. Bring this tracing to school and determine how many of the class

wear shoes that (1) have soles the right size, (2) have soles the right shape for the foot.

2. Shoes should have reasonably thick soles, so that the foot may have a solid support for the weight of the body, and so that the dampness may not easily pass through. Notice the shoes worn to school and judge them on these points. How about your own shoes?
3. Girls often wear shoes with heels that are both too high and too narrow. This gives the foot a cramped, unnatural position, and injures the gait in walking. Are any of the shoes worn to school to be criticized on this point?

Questions to answer.—Why is it especially necessary to have good feet? How many different bones in the foot? Explain what is meant by *flat-foot*. What causes flat-foot? How can you tell whether a person has flat-foot? How may a flat foot or broken arch be cured? Why is it important that one should have shoes of the right size and shape? Describe the kind of shoe that one should wear. What are corns? How are corns caused? How are corns to be cured?

Health Problems

1. Make a study of twenty or thirty pairs of old shoes, noting whether heels and soles are evenly worn. Do you find evidences of flat foot? Of bow legs?
2. Describe the kind of shoes you think boys and girls should wear.

CHAPTER VII

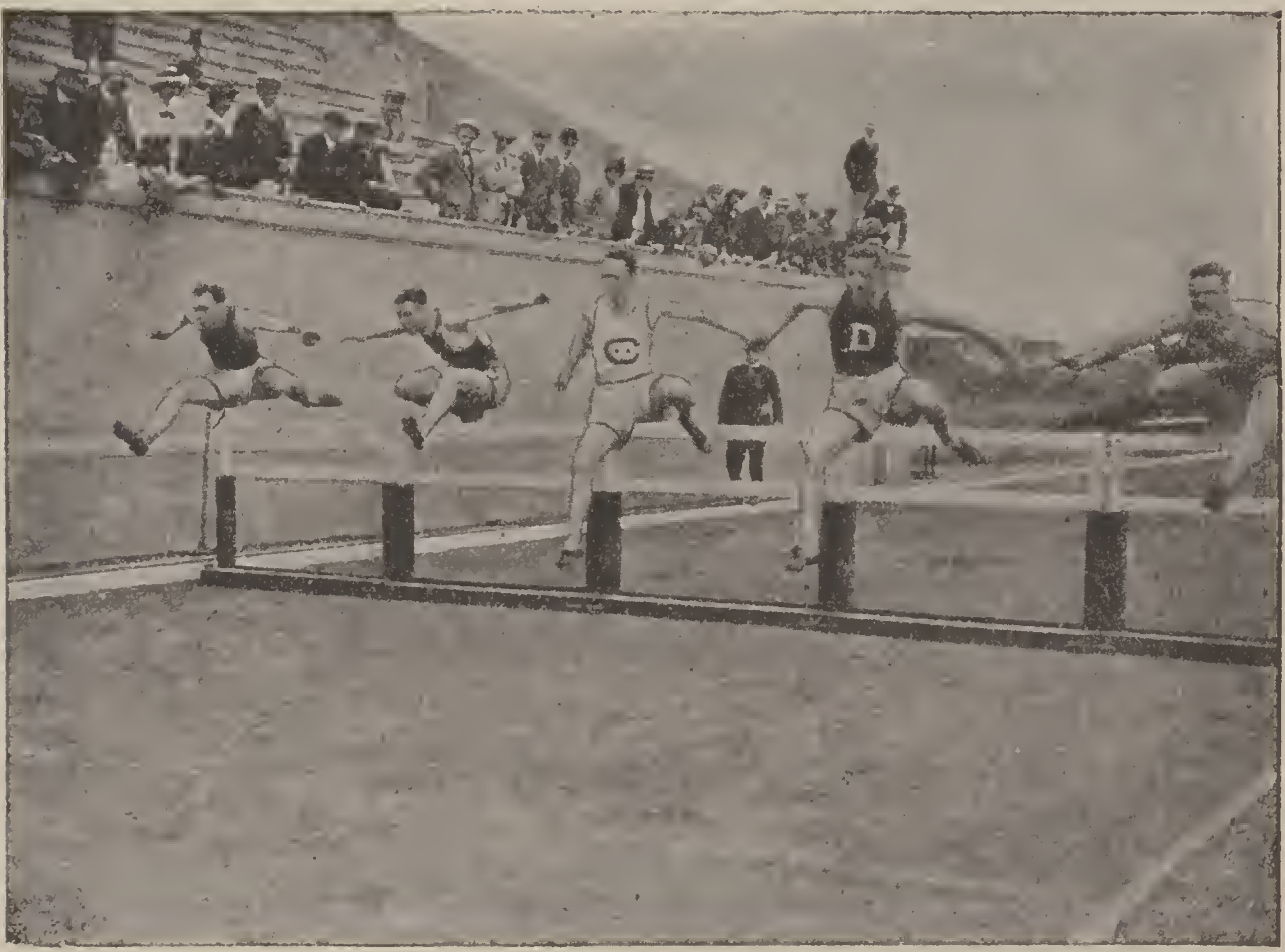
HOW THE BODY IS CONTROLLED

It would be impossible for any one to count all of the different movements made by the five hundred or more muscles of the body in play or in work. In some kinds of work or play almost every muscle of the body is brought into action at the same time. Some of the muscles act with almost incredible rapidity, as we can readily understand if we watch the fingers of a pianist flit over the keyboard.

Muscles are controlled by nerves.—No one of these muscles acts of its own accord. No muscle moves until it is directed to move. Only when muscles are controlled and governed by *nerves* do they contract, and thereby produce movements.

One of my friends was among the first of the American soldiers to go to France after America entered the European war. Nobody knows exactly how it happened, but one day when he was in the trenches a shell exploded near by and a piece struck him. He lost consciousness and when he regained his senses he was in a hospital surrounded by doctors and nurses. He said he felt no great pain, but he was unable to move any part of his body from the hips down.

His muscles were all right and the skin had not even been broken. There was a bruise, however, over his back-bone. This hurt explained the difficulty. The doctors told him that two or three of the small bones



Good nerves no less than good muscles will determine the winner

in the spine had been injured in such a way as to pinch the spinal cord just where the nerves come out which govern the lower part of the body.

An operation was performed which removed the pressure of these bones upon the nerves and our soldier soon found that he was able to move his legs again.

He slowly recovered and was as well as ever in a few months.

Strength of muscle depends upon the nerve currents which flow over the nerves to the muscles just as electricity flows over a wire.—No matter how good the muscles, nor how strong they are, their actual strength depends more on the nervous system which controls them than on the muscles themselves.

There is a little instrument called by the big name *dynamometer*, which is to measure how strong one is in his hand, how much he can grip with his fingers. Now the amount that you can grip does not depend altogether on the strength of your muscles and tendons. It depends even more on the health and vigor of the nervous system which governs your arm and hand. In the same way if you test how heavy a weight you can lift, the amount you lift is not determined chiefly by the strength of your muscles, but by the nervous mechanism which controls those muscles to make them act.

The nervous system determines quickness and endurance.—It is just the same when you run a race. The quickness and length of your stride does not depend alone on your muscles, but also on the nerve currents that run to them.

So also with one's endurance. You may have run in a race until you could hardly drag one foot after

another, then found that when you were nearing the goal you were capable of a sudden burst of speed. This was because a new supply of nerve energy was sent down to your muscles by the thought that you were almost at the end of the race. The endurance that one can show really depends more on his nerve power than on his muscle power.

As a matter of fact the nerves play the most important part in determining our muscular skill. My small friend who is learning to keep three balls in the air at one time is really training his nerves more than he is training his muscles.

Skill depends on nerves.—Expert divers tell us that there is a certain moment in the dive in which one must poise the body at just such an angle in order to strike the water right. If the nerves do not govern the muscles right, the correct movement is not made and the dive is not a success.

No matter how well any act of skill is learned, the nerve currents which govern it must continue to be correct if mistakes are not to be made. No railway company or other concern will to-day put a man in a position of responsibility if he is known to drink. This is because alcohol always injures the steadiness of the nerves and interferes with acts of skill. The engineer who drinks is likely to pull the throttle a little too far or at just the wrong instant and so cause an accident. The motorman who drinks is likely to

be bewildered at some moment of excitement on the street and fail to make the right movement with his switch or brake.

Out for a basket. But he needs steady nerves as well as trained muscles

Nervous embarrassment interferes with skill.— I have a young friend who plays the piano well when he has only his teacher for an audience. But he says that whenever anybody is watching him or listening to him his fingers all seem to go wrong. This is because he has not yet learned to play before company, and his embarrassment disturbs the nerve currents which

govern his hands and arms. He will never be really skilful until he gets over his embarrassment in playing before people. For no matter what the cause, anything that disturbs the natural flow of nervous energy into our muscles will interfere with their action and thus make skill impossible.

Important facts about nerves and muscles.—The following are important points to remember concerning the control of the body by nerves:

1. No muscle contracts or expands except under the direct control of a nerve.
2. The strength, skill, and endurance of our muscles are all dependent on the supply of nervous energy coming in to them over the nerves.
3. Anything that interferes with nervous action, such as the poison of alcohol, fatigue, or even mental embarrassment, will cause an irregular flow of nervous energy into the muscles, and hence disturb whatever skill we may have acquired.
4. We may say, then, that our muscles are no stronger or better than our nervous system which controls them.

Problems and experiments.—1. In the case of an accident or in a time of great danger men have been known to exert much more strength and show more endurance than they could do in ordinary times. Explain why this is possible.

2. Tobacco is known to be especially injurious to the nerve centers and therefore to interfere with the nerve control of muscles. With this fact in mind explain why athletic coaches and trainers will not allow their players to use tobacco during the athletic season.
3. When you are engaged in some long, hard task that tires you, notice whether you feel capable of increased speed and skill as you near the end. Explain this.

Questions to answer.—By what are muscles directed and controlled? Upon what does the strength and quickness of our muscles depend? Why is it necessary to have "strong nerves" if one would have good endurance? Explain how acts of skill, like diving, depend upon trained nerves. Why can one not do so well when he is frightened or embarrassed? Why can one sometimes exert more strength or show more speed in times of great danger than in ordinary times? How does tobacco or alcohol affect nerve strength and control?

Health Problems

1. The basket ball team did good work when they were practising for the championship game, but when the game itself came they showed the effects of "nerves." How can fear or nervousness in such trials of skill be overcome?
2. If you had to run a mile, would you start out at your best clip, or start more slowly and increase your speed gradually?

CHAPTER VIII

BRAIN AND NERVES

The nervous system which controls the action of the body and does all our thinking is so wonderful that it will be worth while to learn something of its structure.

The nervous system consists (1) of the brain, (2) of the spinal cord, and (3) of the nerves which connect the different parts of the body with either the brain or the cord.

The brain.—The brain is shut away in the tightly closed box which we call the skull. The bones of the skull are so strong that the brain is quite thoroughly protected from ordinary injuries by blows or accidents. At the age of fourteen years your brain weighs between two and a half and three pounds. It increases but little in size after this time, but goes on developing for many years.

The main part of the brain which fills all the upper part of your skull is called the *cerebrum*. It is divided into two parts or hemispheres connected by a little bridge, very much as the two halves of an English walnut are joined together. The surface of the cere-

brum is covered over with deep ridges, or folds, which makes its appearance still more like that of a walnut. The spinal cord extends from the brain downward through a canal in the bones of the spinal column to a point about the waist line. The cord is silvery white and is about the size of your little finger.

Nerves. — The nerves act as messengers between the different parts of the body and the brain or cord. If you look carefully at a piece of lean beef before it has been cooked you will be able to find in it tiny silvery white threads. These are nerves.

The brain as it appears in its bony chamber

The nerves which carry the messages of sight, sound, taste, smell, touch, or other sensations into the brain or cord are called *sensory* nerves. Those which carry orders for movements from the brain or cord out to the muscles are called *motor* nerves.

The brain has twelve nerves for each side of the

body. Some of these are sensory, some are motor, some are both combined. These connect the eyes, ears, nose, face, and some of the internal organs with different parts of the brain.

The spinal cord has thirty-one sensory nerves and thirty-one motor nerves for each side of the body.

Each nerve, as it extends from the cord or the brain, begins to branch like a tree and keeps on subdividing until it ends in thousands of little fibers. It is by this branching and subdividing that the forty-three nerves are able to reach all parts of the body. So completely do the nerve endings cover the skin that it is almost impossible to find a spot where a sensory or motor nerve does not reach.

Division of work.—Just as in a factory each group of men are assigned their own particular work to do, so in the brain different parts or areas do their own special work. For example, your nerves of sight run to the very back part of your brain. If you will put the tips of your fingers at the back of your head about as high as the top of the ear, you will then have them resting directly over the sight center. If this particular spot is injured, you can not see, no matter how perfect your eye or how good your nerve of sight. Your hearing center lies at the side of the brain just above the level of the ear.

The muscles of your legs, arms, upper part of the body, face, and eyes, are controlled by a narrow

section of the brain extending from in front of the ear upward and slightly backward. The movements of your speech organs are in part governed by a small area about the size of a silver quarter of a dollar lying slightly in front of the left ear and near the level of the top of the ear.

The white lines show some of the main branches of the nerves reaching to all parts of the body. There are thousands of smaller branches which are not shown

It is thought that the front part of the brain is chiefly concerned with our thinking.

Whenever a sound is to be heard the nerves of the inner ear carry the message in to the right place in the brain and we hear! When an object is to be seen, a picture, or image, of it is formed on the back part of the eye; the nerve of sight carries the message in to the proper spot in the brain and we say, I see a tree, a cloud, a person!

When we taste, the substance must be dissolved in the fluids of the mouth. There it comes in contact

with the little "taste buds," which are located in small red dots or points scattered over the tongue. Here again a message is started in to the brain, this time over the nerve of taste, and you say salt, sweet, sour, or bitter!

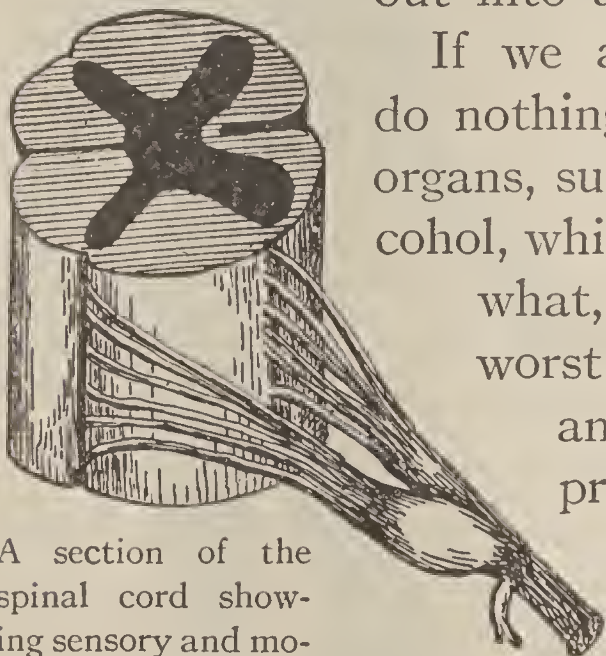
How nerves act.—So it is with smell or touch, or heat or cold, or any other sense. Some proper stimulus excites the little end organ of the sensory nerve; the nerve faithfully carries the message in to the right part of the brain, and the mind gets the information necessary to know the fact it requires.

When movements are to be performed the plan is the same, except that the message now runs out over a *motor* nerve from the brain or cord to the muscle.

For example, the mind gives the order, Pick up the pencil and write. Immediately a nerve message starts from the right area of the brain, runs down over motor nerve fibers to the cord, and so on out to the arm and hand, and the act is performed.

Nerve habits.—Acts or movements that have been performed many times come to "do themselves"; that is, the act becomes a *habit*, as we have already learned. But even though the act may be performed without ever thinking about it or intending it, the fact still remains that the nerve message ordering the movement to be made must come from brain or cord; it must run out over a motor nerve pathway to the proper muscle, and the muscle must then contract and expand so as to produce the required movement.

It is clear then that we need good eyes, ears and other organs of sense so that we may secure the necessary information from the world of sight, sound, taste, smell, etc., around us. We need good brains to receive these messages from the outside world, and to think and plan. We need good motor nerves and strong muscles to carry the mind's thoughts and decisions out into acts and deeds.



A section of the spinal cord showing sensory and motor nerve roots

If we are wise, therefore, we will do nothing to harm any of our sense organs, such as the eyes or ears. Alcohol, which injures many organs somewhat, hurts the brain and nerves worst of all. Even very small amounts of this poison can be proven to lessen the efficiency of the nervous system, while long use produces serious injury. We should not knowingly injure the nerves that bring the messages and carry orders out to the muscles. We should not take into the body alcohol, tobacco or any other poison that will affect the brain. For to injure either brain or nerves means to decrease our power to think and the power to carry our thoughts out into deeds.

Interesting things to do.—1. After studying the drawing of the brain on page 56 place the tip of

your finger over the spot on your brain where hearing is located; sight.

2. In the same way point out the part of your brain which controls the movements of your arms, legs, face, etc.
3. The movements of the speech organs are controlled by a small area on *one side of the brain only*. If you are right-handed the speech center is on the left side of your brain; if left-handed, the speech center is on the right side of the brain. Now point out your own speech center.
4. Look in a mirror or at some other person's tongue and find the red spots where the "taste buds" are located. On which part of the tongue are they scattered thickest?

Questions to answer.—What are the different parts of the nervous system? Where is the brain found? What is the upper and larger part of your brain called? Describe the *cerebrum*. What two classes of nerves are there? What is the work of the sensory nerves? What is the work of the motor nerves? How many nerves are there running to and from the brain? How many nerves attach to the spinal cord? Explain how the spinal cord is protected. What part of your brain is responsible for seeing? What part is responsible for hearing? What parts of the brain control our muscles? What part of the brain is concerned chiefly with our thinking?

CHAPTER IX

THE NERVE CELLS AND FIBERS

One of the smallest living things is a tiny animal called the *amoeba*. The amoeba is so small that it can not be seen without a microscope. When you first look at it under the microscope you will be disappointed if you expect to see an animal with head and body and legs or wings like those you are accustomed to see.

For the amoeba is an animal of *only one cell*. It looks like the smallest particle of the white of an egg. It can change its shape and in that way it moves about slowly. The single cell of which the amoeba consists is made up of what is called *protoplasm*. This protoplasm is *alive!*

Cells and tissues.—The interesting thing about all this is that every tissue of our bodies—muscles, blood, bones, brain, etc.—is made up of living cells of protoplasm. These cells differ in size and shape, but all are too small to be seen by the eye alone.

One particular kind of cells is found only in our brain and nervous system. These are called *nerve cells*. The work of these cells is so important that it will be worth while to learn more about them.

Nerve cells.—About a block from where I live stands a large building made of brick. I know there must be many thousands of brick in its walls, yet from where I sit I can not see any one particular brick. They all blend together in one great mass, which I see only as a building.


A nerve cell

This illustrates the structure of our brain and nervous system. When we look at the brain, for example, it seems to consist of a single mass of rather soft material. But if we will tease a small portion of the brain apart, as we did the muscle, and then look at it through the microscope, we will see that the brain is made up of millions upon millions of separate nerve cells. These tiny cells form the brain just like the bricks make the wall.

How the nerve cells work.—The nerve cells of brain and spinal cord differ in size and shape, but they are all alike in one particular: Each consists of a tiny body of living protoplasm and of thread-like fibers which grow out from the cell's body. We may liken the cell body to an electric battery and the fibers to the wires. Each cell lives its own life and does its own work. In general, we may say that the cell body part of the nerve cell supplies the energy or force by which

the brain does its work, and the fibers carry this energy where it is needed.

No one can explain exactly how it takes place, but we know that all of our thinking, all of our feeling, and all of our acting are made possible by the work of the nerve cells.

We are able to learn acts of skill and to form habits that make us more efficient in our work because the nerve cells can become accustomed to doing these things. If we form bad habits or do our work bunglingly it means that our nerve cells have not yet developed proper control over the muscles.

When we master the multiplication table, commit to memory a poem, or learn how to spell a new word, we have trained our nerve cells to work together on these things. For learning of any sort depends finally on the training of our nervous system.

When, on the other hand, we forget a fact we have known, when we misspell a word, or when we are unable to recite a poem we have committed, it means that some of our nerve cells have, from one cause or another, failed in their duty.

Things that injure the nervous system.—When we see how important these cells are it is easy to understand that anything which will injure them or interfere with their action will harm our thinking and lower the skill of our acts or movements.

The surest way to injure the cells of the nervous

system is by different kinds of poisons, for, as we have seen, a nerve cell is a living thing and may be poisoned just as an animal may be poisoned. Tobacco is a harmful poison and tends to injure the nerve cells.

Under the influence of tobacco the heart becomes weaker, irregular and uncertain in its action. It is this effect which gives the smoker what is called "tobacco heart." The tobacco heart beats now too fast and now too slow.

But a still worse poison for the nerves is alcohol. Alcohol injures practically every tissue of the body, but seems to have a special grudge against the brain and nerves. Careful experiments made by doctors and other scientists have shown that the nerve cells of animals which have been given alcohol are shrunken in size and made feeble in their work. It is this effect that makes the hands of the drinker uncertain, his mind befuddled and all of his powers below their best.

Tired nerves.—Still another poison to which all of us are subject is that which comes from fatigue. Experiments have been made upon pigeons, sparrows, and other birds which fly long distances at great speed. It has been found that their nerve cells shrink very noticeably when the birds are greatly fatigued. These cells recover their full strength and activity only after a period of rest.

This fact explains not only why we have the feeling of fatigue when we have exercised or studied for a long

time, but also why we can not do as good work when we are very tired. The brain by which we do our thinking and which governs our movements is for the time being poisoned by fatigue, and can recover its tone and strength only through rest.

A good way to rest after a hard year's work in school

Important facts to remember.—1. The work of your brain and nerves is done by the millions of cells of which they are composed.

2. Each cell is complete in itself, and joins with others of its kind to do the work of our thinking and acting.

3. The nervous system can be trained so that it gives us good habits or bad habits.

4. The nervous system needs good care. It requires the nourishment that comes from suitable food. It should not be injured by poisons from alcohol, tobacco or any other source.

Questions to answer.—What is an amoeba? Why is it called a *one-celled* animal? What is a cell? Explain how the brain is made up of many cells. Explain how cells are grouped together to make nerves. Why are nerve cells so important? What effect do tobacco and alcohol have on the nervous system? How do nerve cells act when they become tired?

Health Problems

1. Why do people often become cross and irritable when they are very tired? What ought they to do when they feel this way?
2. Suppose you have been using your brain all day studying at school, would you better rest by outdoor play or by sitting in the house reading a story? Why?
3. Why do drunken persons find it impossible to speak their words right, saying "thish" for "this," and so on?
4. Our habits are really formed in the brain and nervous system. Our brains are more plastic and easily molded in youth than when we are older. What, then, would you conclude as to the best time to form desirable habits?
5. Make a list of the five worst habits you can discover among the pupils of your school.

CHAPTER X

THE NERVOUS SYSTEM AT WORK

Some persons have better brains than others. How good a brain one has depends partly on heredity—on what kind of brain was given him at birth; but it also depends a great deal on the training and development we give our brains.

The baby can not learn hard lessons nor think things out for himself; his nervous system is not developed enough to make study and hard thinking possible. The baby's muscles are not so skilful and well controlled as yours, for the same reasons—the cells which direct his muscles are not yet able to do their full work.

The nervous system trained by use.—Our brains, like our muscles, develop daily by being used. The nerve cells and fibers that carry messages of sight or of sound must be given work to do; we must notice and observe.

The nerves that contract our muscles must be given practise in many kinds of exercise and movement; we must work, play, train ourselves to skill in movement; we must develop our motor nerve cells.

The cells by which we do our thinking must also have their training. We must learn right habits of study and reading. We must train our memory and attention. We must learn to plan, reason and think things out for ourselves.

Youth the best time for training.—It is easier to train our brains when we are young than after we become older. The hunter finds that if his setter dog is not trained to point game at an early age, it is impossible to give the right training later. It is "hard to teach an old dog new tricks," for the older the brain becomes the more difficult it is for it to learn new lessons.

This is one reason why boys and girls should attend school regularly and improve their time while there. Many things are learned more easily in early youth than later. When we are young is the best time, therefore, to learn to study, and to form habits of effort, persistence and thoroughness which every person needs for his success.

The effect of an injured nervous system.—The development of our brains may be affected by accident or disease. Not long since I visited in a home where I saw a woman who was about thirty years of age. She was of usual size and strength, but she had a childish, undeveloped look on her face, and she was busy *playing with dolls!*

Of course, it seemed very strange to see a grown person acting like a little girl. Her family explained to me the cause of her condition. When this woman was a little girl of about eight years the children went out skating one winter day and Mary fell on the ice, striking her head a terrible blow.

She was carried into the house insensible, and fever developed. After a time she seemed to recover, but something had happened to her brain. The brain never developed beyond the point it had reached on the day of her fall. Her brain remained like the brain of a child of eight years. Although Mary had been very bright, she was incapable after the injury of learning from her books, or of understanding things about her. When her brain stopped growing her mind ceased its development, and although now almost middle-aged Mary still is a child mentally and will always remain so. So closely is the mind linked with the brain.

The mind injured by harm to the brain.— Injury to the brain may cause insanity. I once knew a man who was working as a bricklayer on a great building that was going up. A heavy iron beam which was being hoisted by chains swung out of position and, when he was not looking, struck him on the head, knocking him to the ground senseless. As soon as he regained his senses, he sprang to his feet and most violently attacked his fellow workmen who were

trying to help him. The ambulance was called, and he was taken to a hospital still raving.

The surgeons who examined him said that a bit of bone had been crushed in by the blow and pressed on the brain at a certain point. It was this that caused his raving insanity. The surgeons immediately performed an operation, prying the piece of bone away from the brain so that the pressure no longer continued. Soon after the pressure on the brain was relieved the man regained his natural state of mind and was no longer violent nor insane. Here again we see the close relation between the brain and the mind.

Effect of alcohol on the brain.—It is well known that a man who is drunk loses his ordinary common sense and becomes silly and foolish. His thoughts no longer work as they should, for he has so affected the nerve cells that they are for a while unable to carry out their usual work. The drunken man's brain is disarranged like some delicate machine that has been thrown out of adjustment.

Good moods and disposition.—Every one knows how good it feels just to be alive on a beautiful day when we are well and bubbling over with cheerfulness. It is likely that most of us also know what it is to have the "blues," to get into the "dumps," or to feel cross, crabbed and sour when things go wrong, or when some slight ailment affects us. This condition of our

feelings, whether of brightness, happiness or the blues, we call our *moods*.

It is very important that we should be in good moods because our moods grow into disposition and character. A certain girl of my acquaintance grew up in a very unfortunate way. In the first place this child's health was not good, and her nervous system was not in normal condition. Added to this she was often made unhappy and cross by being teased and scolded. The result was that her moods were generally bad. Her face wore a scowl and her mind was filled with bitterness. Because she continued in this state of mind from day to day her disposition grew at last to be sour, ugly, and forbidding, until to-day she is not a very pleasant person and does not have many friends.

Good health and the habit of smiling will go far toward insuring a good disposition and a pleasing manner

Another child, a boy whom I know, grew up in just the opposite way. Every one in his home was good-natured and happy; cheerfulness was the rule of the day; teasing was banished by common consent. Un-

kind words and faultfinding were always discouraged, and everybody seemed to try his best to be pleasant and good-natured. It is needless to say that this boy has grown into a youth of most lovable disposition and character.

How character grows.—Tell me the kind of moods you live in from day to day and I will tell you what your disposition and character soon will become. The way you use your brain to-day will determine the kind of brain that you will have for your mind to work through to-morrow. You can not fill your mind with worry, fretting, crossness, ill-nature, jealousy, and bitterness without training your brain to a disposition that will make you unhappy and cause you to be unpleasant to your friends and associates.

On the other hand, suppose you keep your body in health, your mind full of good cheer and happiness, and your thoughts occupied with pleasant things. Then your brain will so become accustomed to habits of good cheer and happiness that your disposition and character will be pleasant and you will have many friends.

Interesting things to think about.—1. How many different kinds of birds do you know? How many kinds of trees? Of wild flowers? How many different birds can you recognize by their notes? Have you the habit of noticing things about you—is your observation good?

2. What games or other acts of skill do you excel in? Is your penmanship good, and are your written lessons neat, thus showing good control by your motor nerves?
3. Do you often get sour or cross? Do you have the "blues"? Do you ever pout and remain in a bad temper? Or are you generally happy and cheerful? What difference will this make in your disposition?
4. Judging from your answers to number three, what kind of a disposition do you think you are developing, good or bad?

Questions to answer.—What two things determine whether we have good brains or not? How are our brains to be trained? What is the best time for training the brain? What may hinder the development of our brain? What story can you tell to show that the mind is closely connected with the brain? Why is a drunken man's mind foolish and silly? What is meant by our *moods?* Explain how moods may grow into *disposition.* Tell also how character is formed.

Health Problems

1. What do you think are the qualities of disposition that make people like us and desire us for friends? Do you think we can cultivate desirable dispositions and cure ourselves of bad traits?
2. Did you ever know a person who would be pleasant enough to strangers or friends and then be cross and faultfinding at home? Where do you think good nature should begin?

CHAPTER XI

GETTING RID OF FATIGUE

Every one knows the feeling of fatigue—what it is to be tired. Every one knows, too, that when we are very tired we can not do our best either in work or in play.

We can better understand about fatigue if we know, to begin with, that long-continued activity, either of muscle cells or nerve cells, manufactures a poison. If this poison is not produced too rapidly, that is, if we do not get too tired, it is washed out from the tissues as fast as it is made, the blood carries it away, and we do not seriously feel its effects.

The poison of fatigue.—If, however, we become too greatly fatigued, if fatigue continues for too long a time, or if the circulation of the blood is not good, then the load of poison becomes more than the blood can take care of. It is this fatigue substance which gives us the feeling of weariness when we are tired. It is also the effects of this poison which cause our muscles and nerves to act less efficiently when we are very tired than when we are rested and in good physical condition.

We are not to understand that it harms one to become tired. A reasonable amount of fatigue does one no injury. In fact it is necessary for health and development that we exercise enough to feel some degree of fatigue. For in order to use our muscles, heart and lungs sufficiently to keep them in good health and strength we must exert ourselves enough that some fatigue is felt.

Only severe fatigue injures.—It is only when fatigue is too severe, or when it is too long continued that it becomes harmful. The over-fatigued cell is soon an injured cell. To illustrate, I have a friend, a brilliant lawyer, who has broken down from overwork. His law practise was heavy and he did not take sufficient exercise and recreation. After a little time he felt extreme weariness and did not rest well when he tried to sleep. He would awaken in the morning feeling almost as tired as when he went to bed. This continued for a time, and then he became actually ill, and the doctor now tells him that he will have to be away from his work for at least half a year.

Exercise a cure for brain fatigue.—Every school boy and girl has noticed that we often come from the school room in the evening feeling very tired, and perhaps out of sorts. A good game of ball or a romp through the woods will then rest us wonderfully and make us feel as good as new.

This is because the exercise in the open air has started our blood to flowing faster, and the fatigue substances have been washed out of our tissues. It is easy to see, therefore, why one who is fatigued from brain work needs to exercise his muscles in the open

Digging clams while the tide is out. The next thing will be a "clam bake"

air. This sets the heart to beating and the blood to surging through every part of the body, and the fatigue poisons are swept away, so that we again feel rested and fresh.

Massage for muscle fatigue.—The other day I went to a field meet, where a number of runners were competing in races. I noticed that the trainers and coaches were rubbing or massaging the muscles of the

runners between races. This was to rest them and help prepare them for the next race. In fact, massaging will bring an almost immediate feeling of relief and restfulness to any one who is fatigued.

It is clear why massaging the muscles will relieve the feeling of fatigue. For the kneading, pulling, twisting and rubbing of the muscles in massage increases the flow of the blood through them. The faster the blood flows through the muscles the more quickly will the fatigue substances be washed out of them, and the sense of fatigue leaves us.

Rest and sleep remove fatigue.—One of the surest and best ways to remove fatigue poisons from our bodies is through rest and sleep. Who has not gone to bed after a busy day feeling almost too tired to undress properly, and then awakened in the morning feeling as bright and as fresh as if he had never thought of being weary! We should be able thus to rest quickly and completely. If we are in good health and our blood circulation is strong, nature, by removing the fatigue poisons from our muscles and nerves while we sleep, makes us ready during the night to begin a new day as fresh as ever.

Fatigue from worry.—Worry is one of the worst causes of fatigue. Some people have the habit of worry. They worry over their work instead of getting at it to complete it. They worry for fear the rain will

spoil the game or the trip. They worry over their examinations, though by daily mastering their lessons they are sure to pass them. In short, after one has once formed the habit of worry, he finds it easy to worry over anything or nothing. And all this worry is sure in the end to injure his nervous system and interfere with his work.

Important facts to remember.—1. Fatigue is accompanied by poisons left in our tissues. These poisons must be carried away by the blood in order that we may be rested and well ready again for work or play.

2. If the fatigue is not too severe or continued for too long a time, the poisons are easily removed and no harm is done. The poisons of some slight diseases of which the person is scarcely conscious produce this same feeling of fatigue. A constant feeling of weariness and lack of ambition may show that fatigue poisons are being left in our tissues or that we have some slight illness. Loss of health is sure to follow if these poisons accumulate.

3. Safe rules to follow.—Stop short of very extreme fatigue, either physical or mental. Banish worry, ill temper, fretting and spite; they not only injure the disposition, but greatly increase fatigue poisons. Exercise wisely, get plenty of sleep, breathe deeply of fresh pure air.

Problems and experiments.—1. After going to bed very tired do you awaken in the morning fully rested, or do you still feel weary? Do you ever feel rested if you have not slept well? Do you have fresh air blowing into your room, and is the temperature cool enough for good sleeping?

2. Try bringing on muscular fatigue in two different ways, as follows, and watch the feeling of fatigue as it grows: (1) Take a standing position and hold a book in your hand with your arm extended for two or three minutes. (2) Take a comfortable sitting position with your feet resting squarely on the floor. Now with the heel remaining on the floor tap with the toe of one foot as fast as you can for several minutes. Does the tapping finally become slower and rather irregular? Why?

3. The person who works all day with his muscles can rest best by sitting or lying still. The person who works with brain can rest best by some game or other activity that uses his muscles. Explain the difference in the way of resting. Tell how boys and girls should rest after a day in the school room.

Questions to answer.—What is the result of long-continued fatigue? How is fatigue poison removed from the tissues? Does it harm one to get moderately tired? Give the case of the lawyer who broke down

from overwork. Explain why a good romp or a good game will rest us after a day in the school room. How does massage help remove fatigue from the muscles? Tell one good reason why people should learn not to worry. Give four good rules to follow with reference to fatigue.

Health Problems

1. Do you ever get too tired to be hungry? Or too tired to go to sleep? Is it well to carry fatigue to this point?
2. Do you feel rested and refreshed after a night's sleep, ready for a new day, or do you sometimes awaken still tired and dreading to go at your work? What causes might lead to the latter condition?
3. Explain how one may often rest by change of exercise or occupation.
4. How many hours should one of your age sleep each night? How many hours *do* you sleep?
5. Give rules to be followed in order to get the rest and recuperation necessary from our sleep.
6. Have you ever noticed that you dream troublesome dreams when you have eaten indigestible food before going to bed? Do you ever dream at night about things that worry or excite you during the day?
7. What rules can you give which will favor your going to sleep promptly upon retiring?
8. What rules can you give which will favor your waking up quickly at the proper time, feeling refreshed and ready for another day?

CHAPTER XII

THE BLOOD AND ITS WORK

Blood necessary to the life of the body.—Blood is so necessary to the welfare of the body that the loss of even a moderate amount causes great weakness. The boy or girl who reads this book has about three or four quarts of blood in his or her body. If one-half of this blood should suddenly be drawn off, death would follow.

The danger from loss of blood is shown in a newspaper item telling of an accident which occurred in Chicago. Two small children were left alone while their mother went shopping. They found a sharp paring knife and were playing with it. In some way the younger child received a deep cut across the wrist. This opened the large artery there, and the blood poured out in a stream. When the mother returned, the little one was dead from the loss of blood. The cut itself would not have been serious, but the blood supply of the body had drained out. Without blood the body can not live.

Blood and strength.—Good blood is necessary to health and strength. In a hospital near where I sit

writing, a woman lay ill and almost dying from sòme disease which had affected her blood and made it unable to nourish her body. Her weakened blood was so useless that it was much as if a vein or artery had been opened and her blood allowed to run out. The physician said that if she could have a quart or two of good, fresh, strong blood put into her veins her life might be saved and she would have a better chance to recover.

This woman had two sons, both strong, healthy fellows. The sons came to the hospital and the surgeon removed a pint of blood from each and injected it into the vein of their mother. This brought about improvement in her condition and she recovered.

It can not be too strongly impressed upon us that health, vigor, growth, strength—even life itself—depend on a good supply of healthy blood driven through the body by a strong heart.

What the blood is.—We will understand the nature of the blood better if we study the various parts of which it is made up. The blood consists of three different parts or substances: (1) the liquid part, which is called *plasma;* (2) the *red corpuscles;* and (3) the *white corpuscles.*

The plasma.—Although the blood looks red, the liquid part, or plasma, is almost colorless and nearly transparent. The plasma is nearly nine-tenths water.

Yet this watery liquid carries dissolved in it the food material for the nourishment and growth of all the different tissues of the body.

The bread, milk, meat and eggs you have for your dinner are picked up by the blood as soon as they are digested. They become a part of the plasma. The plasma then carries this liquid food to the various tissues of the body, where each cell picks out the particular food materials needed for its growth and repair. The food you eat to-day, thus distributed by the plasma of the blood, becomes the muscles, bones, nerves or fat of your body to-morrow.

The red corpuscles as they show under the microscope. The larger circular body is a white corpuscle

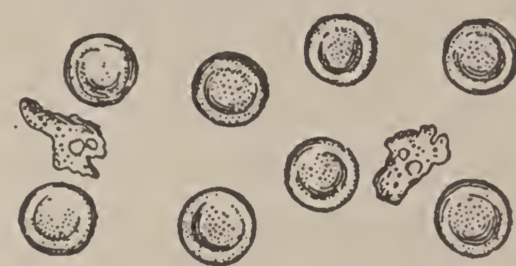
Besides carrying the food supply to the tissues, the plasma does still other important work of transportation. It has dissolved in it many kinds of waste material which it gathers up and helps remove. It also carries floating in it the red and the white corpuscles.

The red corpuscles.—It is the red corpuscles which give the blood its color. The word corpuscle means *small body*. The red corpuscles are so very small that you can not see one of them without a powerful microscope. They are so small that many millions of them are found in one drop of blood.

Red corpuscles are disk shaped, each side being

concave, or slightly hollowed inward. Under the microscope they look something like small coins, except for being concave instead of flat on the sides. The red corpuscles are manufactured in the marrow that fills the hollow bones, and pass from there into the blood.

Work of the red corpuscles.—The great business of the red corpuscles is to carry oxygen from the lungs to the different tissues of the body. The red corpuscles have the power to absorb oxygen, much as a sponge takes up water. As the blood comes in contact with the air cells of the lungs each red corpuscle absorbs its tiny load of oxygen and rushes away in the current of the blood carrying its precious burden to some tissue which is given the oxygen it requires.



The circular disks are red corpuscles very highly magnified. The irregular bodies are white corpuscles

Oxygen has the effect of making the corpuscles a brighter red. Thus oxygen-laden blood coming through the arteries from the lungs is of a bright scarlet color. When the corpuscle has lost its oxygen it takes on a dark, purplish hue. Hence the blood that is on its way through the veins back to the heart has a darker color than that in the arteries.

The white corpuscles.—The white corpuscles are a little larger than the red corpuscles. They also are

much too small to be seen except with the aid of a microscope. They are irregular in shape. In fact, they have the power to change their shape, and so are found in a great variety of forms. It is by changing their shape that they move about; that is, they project a part of themselves in the direction in which they wish to go and then flow or move in that direction.

There are not nearly so many of the white corpuscles as of the red. The proportion is not always the same, but in general we may say that there are about seven hundred red corpuscles for every white one. The work of the white corpuscles is so important that we shall take it up for further study in another lesson. Suffice it to say now that their great work is to fight the disease germs that get into the body.

How nature stops bleeding.—You have noticed that the bleeding from a scratch or cut soon stops of its own accord. This is because when blood is exposed to the air it thickens, or *coagulates*. This is nature's method of stopping the bleeding of a wound and of forming a healing covering over a cut. The coating of blood that hardens over the edges of a wound is a better healing salve than any medicine that has ever been invented.

Interesting problems and experiments.—1. The next time your father kills a chicken for dinner you might ask him to save some of the blood

in a dish. After the blood has stood for several hours note that it is no longer red as it was at first, but that there is a darkish mass or *clot* floating in an almost transparent liquid. The clot consists of practically all the corpuscles entangled in a network of fibers, called *fibrin*, which formed in the plasma; the clean yellow liquid in which the dark mass floats is the *serum*. The serum is the plasma after the fibrin has all separated out.

2. When you have had the nose bleed, you may have noticed that the blood comes from the nostril at times in small clots. Explain how the clots are formed.

3. A boy whom I know has great difficulty to stop the bleeding from the smallest wound, a slight cut sometimes continuing to bleed for hours. The physicians say his blood lacks *fibrin*, the substance which causes clotting. Think how troublesome and dangerous all cuts and wounds would be if nature had failed to provide for the clotting and hardening of blood when outside the veins and arteries.

4. Children sometimes hold their breath when angry until their faces become purple, or almost black. Recall the effect of oxygen on the red corpuscles, and then explain the dark color.

Persons who have been drowned or suffocated turn dark in the same way. Is the cause the same?

Questions to answer.—How necessary is blood to the body? About how much blood has a boy or girl of your age? Tell the story of the child whose wrist was cut while its mother was away. Tell the story of the woman who had fresh blood put into her veins from the veins of her sons. What three parts does the blood consist of? Describe the plasma. Describe the red corpuscles. What is the work of the red corpuscles? Describe the white corpuscles. Tell how nature stops bleeding from a wound.

Health Problems

1. Many patent medicines are advertised as "blood purifiers." Is there any such thing as a blood purifier? (The blood is pure unless some diseased condition of the body is putting a poison into it. In this case the disease should be cured, then the blood will be pure.)
2. When the doctor wants to make sure whether his patient has typhoid fever he draws a drop of blood from him and has it examined. How can it be told from the blood whether the patient has typhoid?
3. Tie a string tight around your finger and leave it for fifteen minutes. What is the appearance of your finger? What causes this appearance?

CHAPTER XIII

THE CIRCULATION OF THE BLOOD

We have seen in the preceding lesson how necessary the blood is to the life of the body. But in order to be of use the blood must be in constant circulation. Let the heart cease for only a few moments to drive the blood on its endless round through arteries and veins, and the person dies as surely as if his blood had been drained away.

Every one is to-day familiar with the fact that the blood circulates over the body. We have even measured the speed at which it moves, and know that the whole blood supply is pumped the entire round of the body in less than one minute. It seems strange to us that even scientific men did not know these facts in ancient times.

Discovery of the circulation of the blood.— True, even the ancients knew that the blood is contained in tubes, and that an animal or a man dies when the heart stops beating. They also knew that there are different kinds of vessels or tubes for the blood. One kind they called *veins*, and the other *arteries*. They made a strange mistake at this point, however.

The veins, they said, carry the blood of the body, and the arteries carry a "vital fluid" similar to air. They were led into this mistake, no doubt, through studying the blood-vessels of a dead body. The blood of a person who has died settles in the veins, leaving the arteries empty. Hence the ancients thought that the arteries, even during life, must contain nothing but air, or some "vital fluid."

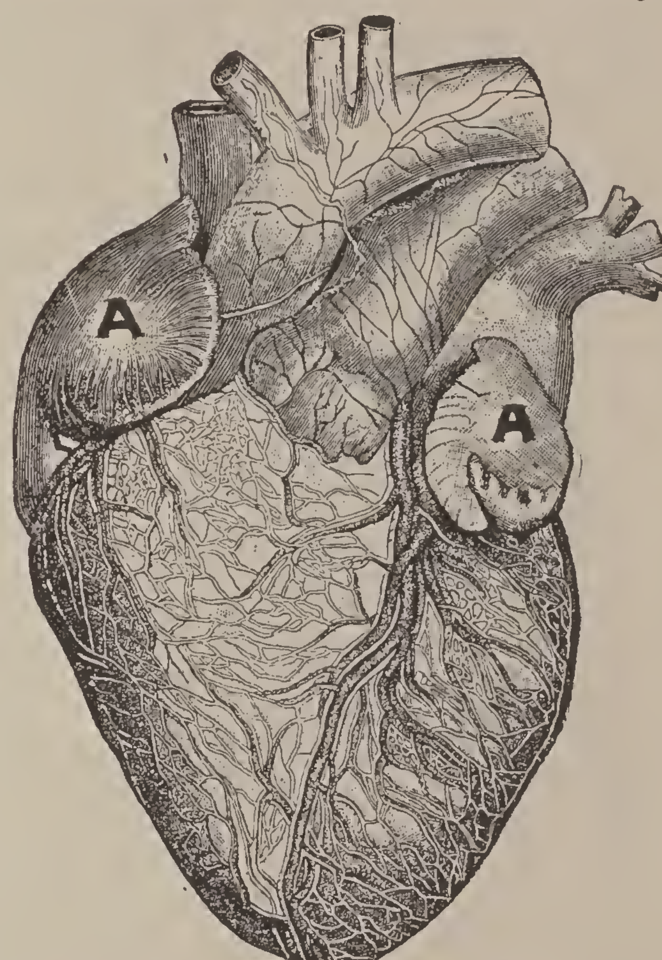
We owe the discovery of the circulation of the blood to the English scientist, Harvey, who lived about three hundred years ago. He performed a series of brilliant experiments in which he proved beyond all question that the blood flows in a ceaseless current throughout all parts of the body. He also proved that without this constant flow of blood one can not live beyond a few minutes.

The blood affords a transportation system.— We may think of the blood and the machinery for its circulation as a great transportation system. The blood-vessels are like canals, and the heart is an engine which keeps the current always moving.

Whatever substance or material needs to be moved from one part of the body to another is thrown into the blood channel, by which it is carried along to its destination. The cells and tissues must have food; so the blood current receives the digested food and sweeps it along to the places where it is required. Every part of the body must have its supply of oxygen;

so the blood goes to the lungs, takes on a load of oxygen, and delivers it to the tissues that need it. Waste matter must be removed; so the blood washes up the waste from among the cells of the body and bears it away.

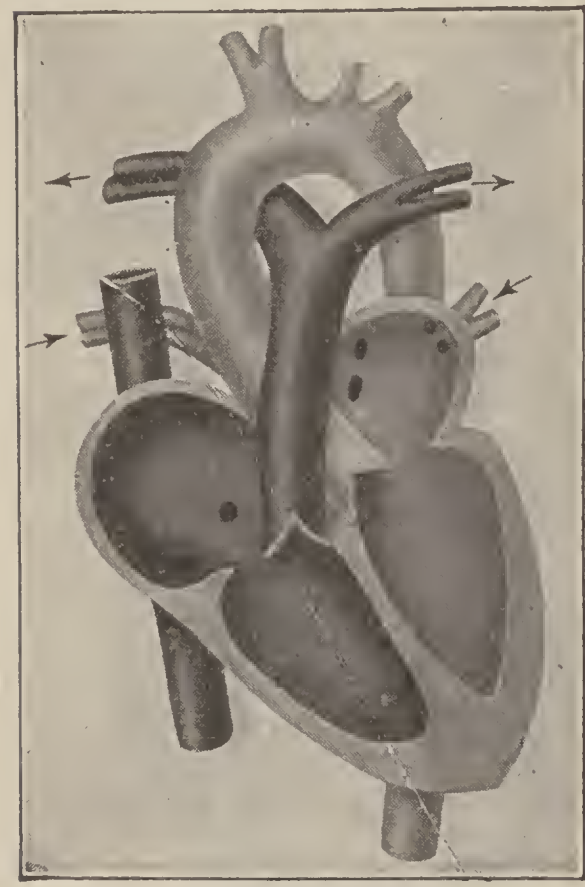
The heart.—For centuries people have known that the heart is an important organ, but just what the heart does was not known until modern science showed us what its work is. The heart has been called "the seat of life," and was thought at one time to be the source of our affections and feelings. Even yet we speak of a person as being "good hearted." But now we know that the heart has only one function, that is *to keep the blood moving.*



The heart with its larger blood-vessels. The parts marked A are the auricles.

The heart is a very strong pump, or syringe. It consists of a hollow muscle, divided into four chambers, two on the right side and two on the left. The two upper chambers are called *auricles*, and the two lower chambers *ventricles*. The auricle on each side opens downward into the ventricle under it.

The chambers of the heart.—Some day when your mother is serving boiled heart for dinner it will be worth your while to notice the structure of the heart before it is cooked. The auricles at the top are rather small and their walls thin. The greater part of the mass is made up of the walls of the ventricles, which are much thicker. You will note that the muscle of the left ventricle is much thicker than that of the right.



The chambers of the heart and their blood-vessels

The explanation of the difference in thickness of the muscle walls is very simple. Nature gives each part the strength required of it by its work. The auricles serve as cups to receive the blood as the veins bring it back to the heart and merely empty it into the ventricles. The ventricles, when they have received the blood from the auricles through small gateways or valves between the two, must force it to all parts of the body. It is clear then that the auricles will need less strength than the ventricles. The left ventricle is much thicker and stronger than the right ventricle;

this is because the left ventricle drives the blood throughout the body, while the right ventricle sends it only through the lungs.

The "beats" of the heart are the contracting and expanding of its muscular walls. This goes on at different rates, as we have already learned, but usually from seventy to eighty times a minute. Exercise, excitement, and stimulants such as alcohol and certain other drugs, cause the heart to beat faster. The heart also beats more rapidly when we have fever. During sleep or when we are at rest the action of the heart is slower.

The arteries.—The tubes leading away from the heart are the *arteries*. Opening from the left ventricle is the *aorta*, the largest artery of the body. This artery branches and subdivides like the trunk of a tree, until it has given rise to thousands of smaller arteries leading to different parts of the body.

The left side of the heart receives the blood as it comes from the lungs, where it has been purified. The blood driven out through the aorta and to the arteries connecting with it is therefore fresh and pure, its bright red corpuscles laden with oxygen for the tissues.

Place your finger at a certain spot near the outside of the front of your wrist and you can feel your "pulse" beat. What you feel is really the throb, or expansion and contraction, of the radial artery which happens to come near the surface at this point. The arteries have

elastic walls, and they expand with every throb of the heart, because the heart-beat sends a wave down the arteries just as a stone thrown into a smooth pond sends a wave over the water.

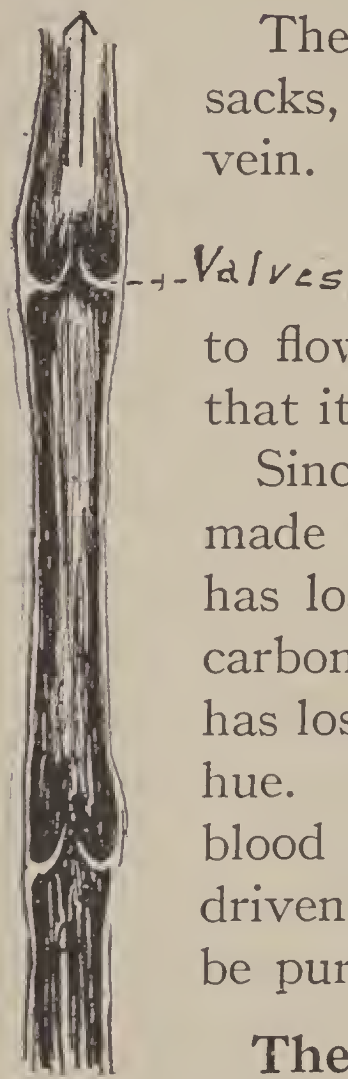
Old age and certain diseases cause the walls of the arteries to harden, and by hardening to become smaller so that they are less able to carry blood to the various organs. The condition of the arteries is so important that the doctors sometimes say "a man is as old as his arteries."


The chief arteries and veins of the neck

The veins.—The work of the veins is to carry back to the heart the blood that the arteries have carried away from it. The veins, too, have elastic walls, but the waves caused by the heart-beat have spent themselves before they reach the veins, so they do not throb as the arteries do.

If you will let your arm hang down until the blood has had time to settle somewhat in it, and then stroke along a vein pushing the blood toward the hand, you will notice small knots appearing along the vein. Each of these knots shows the location of a small *valve*,

or pocket, inside the vein. The purpose of these valves is to keep the blood from flowing backward from the heart.



A section of a vein showing its valves

The valves of the veins are small flaps, or sacks, growing out of the side wall of the vein. When the blood is moving toward the heart, the flaps lie flat against the inside of the vein. If the blood starts to flow backward, the flap is pushed out so that it closes the vein and so checks the flow.

Since the blood carried by the veins has made its tour of the body it is impure. It has lost its oxygen, and taken on a load of carbon dioxide and other waste material. It has lost its bright red color and is of a darker hue. When the veins have returned the blood to the right side of the heart it will be driven by the right ventricle to the lungs to be purified again.

The capillaries.—We have now seen how the arteries carry the blood away from the heart and how the veins bring it back again. But how does the blood get from the arteries over into the veins? And of what use to the body is the blood in the arteries and veins? For their walls are quite thick and no food or oxygen can possibly leave them. These are questions that puzzled the scientists for many years. Finally, with the help

of their microscope they discovered that the arteries, which as we have learned keep on branching into smaller and smaller tubes, continue this branching until the little vessels are so small that they can not be seen with the eye alone.

The microscopic vessels in which the arteries end are called *capillaries*, a word which means hairlike. The capillaries then unite to form a vein, much as small rivulets and streams join to form a larger river. The blood gets from the arteries to the veins, therefore, by passing through a network of very small vessels, the capillaries, which are found in all parts of the body.

A network of blood capillaries as they look under the microscope. Corpuscles are seen in the blood stream

The capillaries differ from the smallest arteries from which they arise and also from the smallest veins into which they empty, since their walls are so thin that the plasma of the blood can pass through them, carrying food to the tissue. It is while slowly moving through the capillaries that the blood does its work. Here it gives up its food substances to the tissues, and gathers up the waste materials which it is to carry away. Here also it surrenders its oxygen and picks up its load of carbon dioxide to carry back to the lungs. Without these capillaries the blood-vessels

would resemble a water system for a city without any faucets where we could get water, or, better, the body would be like a city through which many railroads passed, but with no stations where the trains could stop. Trains full of food might pass through the city but none be unloaded.

The three kinds of blood-vessels.—In case of an injury we may know from the way a wound bleeds which of the three kinds of blood-vessels have been cut. If the bleeding is slight, the blood coming but very slowly, we may conclude that only capillaries, or some of the smaller branches of veins and arteries, have been opened.

If the blood flows more freely, but in a steady stream, a vein has been cut. But if the flow is free and the blood comes in spurts, then we may be certain that an artery has been severed, for each spurt represents the beating of the heart.

Important facts to remember.—1. The blood is a great transportation system, something like the rivers and canals of a country. It carries the food to the parts where it is needed, bears oxygen to the tissues, and transports waste materials. Anything that interferes with the circulation of the blood hinders growth, health and strength.

2. The circulation of the blood depends on the heart and arteries. To have a weak heart or

weak arteries means a poor circulation. Alcohol interferes with the heart. Tobacco also is injurious to the heart. Doctors often speak of the "smoker's heart," meaning a heart whose action has been injured by the use of tobacco. When we expect athletes to be at their best we do not allow them to use either alcohol or tobacco; then why should any person who wants to be at his best use them!

Interesting things to do.—1. Locate your own pulse beat in the wrist and count the beats (1) when you first awaken in the morning; (2) when you are sitting quietly in the school room; (3) just after you have been running or playing hard. How many beats in one minute in each case?

2. Learn to take the pulse beat of other people by counting the pulse of members of your family or your schoolmates. Can you locate pulse beats at other points than the wrist, as in the temple, or the throat?

3. If your school has a good microscope you can *see* the corpuscles of the blood flow through the capillaries. This is what you will have to do: Capture a frog without injuring it. Have your teacher help you bind it comfortably down on a thin strip of board, through which a half-inch hole has been bored. Fasten one of the frog's

feet so that it will have the web directly over this hole. Now place the frog and board in such position on the microscope that you can look through the web of the foot. The wonderful sight you will behold will fully repay you for all the trouble. And the frog will not be injured if you handle it carefully.

Questions to answer.—What is meant by the circulation of the blood? How long does it take for the blood to go the entire round of the body? What did the ancients know about the circulation of the blood? Tell about the discovery of the English scientist, Harvey. Explain how the blood acts as a transportation system for the body. What work does the heart do? Describe the chambers of the heart. How many times does the heart beat in a minute? What are the arteries and what is their use? What are the veins and what is their use? What are the capillaries and what is their use? Describe an experiment by which one can see the corpuscles flowing through the capillaries.

Health Problems

1. Very old people or persons who are ill often have trouble to keep their feet warm. Why is this?
2. Suppose the valves in the heart refuse to work, what would be the effect on the circulation of the blood?
3. What rules for exercise or taking part in athletics can you give to protect the heart from overstrain and injury?

CHAPTER XIV

BLOOD AND LYMPH

No doubt a puzzling question may have occurred to you as you read the last lesson. If the blood is all contained within a closed system of tubes which we call arteries, veins and capillaries, how does it deliver the food and oxygen it carries to the tissues outside the blood-vessels? How does the blood pick up the carbon dioxide and other waste products from the cells of our muscles and nerves if it does not come in contact with them? The capillaries do, as we have said, have thin walls, nevertheless they are all closed on their sides and no blood can get out.

Let us see whether we can not best answer these questions by first asking another. Some time when you have received a slight scratch on the skin or had a piece of skin scraped off not deep enough to bring the blood, have you noticed a watery, colorless liquid oozing out? This fluid is called *lymph*. When we know just what lymph is and what it does I think we can answer the questions with which we started this chapter.

An experiment.—A simple experiment will help us understand the nature of lymph. Go to the meat

market and ask the butcher to give you a piece of thin animal tissue, such as the bladder or a part of the large intestines. Now fill a small glass with salt water and, having washed the tissue clean, tie it tightly over the top. Set the small glass inside a deep dish and fill the dish with fresh water.

Let the glasses stand in this way for several hours. Then taste the water in the larger dish. You will find that it is distinctly salty. Remove the smaller glass and taste the water in it. You discover that it is less salty than when you put it in. Evidently the water in the two dishes has mixed.

What has really happened is that the salt has passed through the animal tissue and mixed with the fresh water outside. This we call *diffusion.* There are many substances that have the power to pass through animal tissues in this way. The white corpuscles are able to crawl through the walls of the capillaries to the tissues outside, and then find their way back into the capillaries again. The oxygen from the air passes through, that is, diffuses through, the thin tissue of the air cells of the lungs and the walls of the capillaries of the lungs, and enters the red corpuscles of the blood. In the same way carbon dioxide passes from the blood out through the walls of the capillaries and the air cells and is expelled from the body.

The lymph.—We are now ready to understand how this principle applies to the blood and the lymph. The plasma, as we have seen, is the liquid part of the blood. Certain fluids of the plasma are constantly passing through the walls of the capillaries, carrying with them the food materials for the tissues and the oxygen which has been set free from the red corpuscles. Since the red corpuscles can not pass through the walls of the capillaries, the watery liquid, or *lymph*, found outside the blood-vessels is nearly colorless.

Every tissue of the body, in fact, every cell, is constantly bathed by the lymph. From the lymph the tissues select the food substances they need and appropriate them. Muscles, bones, nerves—each takes the materials required to build up its tissues. From the lymph the oxygen is taken for the use of the cells. Into the lymph are thrown the carbon dioxide and other waste materials to be removed.

Just as fluid of the plasma finds its way out through the walls of the capillaries and mingles with the lymph, so fluid of the lymph finally passes through their walls back into the capillaries. A constant exchange is therefore going on between the plasma and the lymph, and yet plasma and lymph are never just alike. Whatever the blood contains of materials needed by the tissues goes over into the lymph. Substances that the tissues are through with and that should go into the blood to be disposed of go from the lymph

into the blood-vessels. It is clear that the lymph plays an important part as a carrier between the blood and the tissues.

The circulation of the lymph.—The lymph is contained partly in open spaces among the tissues, and partly in a system of very thin-walled vessels. The vessels carrying the lymph are very irregular in shape, and the movement of the lymph in them is much slower than that of the blood in the veins and arteries.

The network of vessels which carry the lymph

Like the system of veins for the blood, the smaller lymph vessels keep uniting to form larger ones. Like the blood in the veins, also, the lymph tends to flow back toward the heart. The large trunk of the lymphatic vessels, called the thoracic duct, finally opens into a great vein near the heart, where the lymph is poured directly into the blood circulation.

The flow of the lymph is helped along by the action of the muscles. When muscles contract and expand they drive forward the lymph which is in contact with them. It is evident, then, that muscular exercise will

help the lymphatic circulation just as it will aid the circulation of the blood.

Massaging also aids the flow of lymph. In massaging, the pressing, kneading and squeezing of the muscles should be in the direction in which the lymph is flowing—that is, toward the heart. By this action the lymph is moved along more rapidly, thus washing the tissues of waste and bringing them food materials.

Lymphatic glands.—Scattered here and there along the lymphatic vessels are small *glands*, most of them much smaller than a pea. These glands serve as filters to remove poisons from the lymph. When they do this they sometimes swell up and become sore. For example, blood poisoning or a very severe sore on the hand may cause small knots or "kernels" to swell along the arm, or especially in the arm-pit, where there is a large collection of lymphatic glands.

Tuberculosis, or even a severe cold, sometimes affects the lymphatic glands of the throat and neck, causing them to swell and become very sore. These glands may even break down and discharge pus, and have to be removed by the surgeon. Any sore lumps or "kernels" about the throat or neck should be shown the doctor at once.

Important points to remember.—1. We have two distinct systems of circulation of life-giving

fluids in the body, (1) the circulation of the *blood*, and (2) the circulation of the *lymph*.

2. The blood circulation is in a *closed system*, consisting of the heart, the arteries, the veins and the capillaries. There is no opening nor outlet from this system unless the blood-vessels be injured by accident or destroyed by disease.
3. The lymphatic circulation is carried on partly by a movement of the lymph in direct contact with the tissues, and partly within a system of very thin, irregular vessels called *lymphatics*, which lead toward the heart.
4. These two systems of circulation are equally important; neither would be complete without the other. The aggregate amount of the lymph is considerably greater than the amount of blood. The body of a person who weighs one hundred pounds contains about *six pounds* of blood, but about *twenty-five pounds* of lymph.
5. Vigorous exercise is good for either system of circulation. The work or the play that causes the heart to beat strongly and drive the blood coursing through the veins and arteries, also hastens the flow of lymph among the tissues.

Questions to answer.—What is lymph? Where is lymph found? What work is done by the lymph? Describe an experiment which explains how the lymph can pass through the walls of the blood-vessels. Why

is the lymph not red like the blood in the veins and arteries? In what direction does the lymph constantly flow? What carries the lymph back toward the heart? What is the effect of massage upon the flow of the lymph? What are the *lymphatic glands*, and where are they found? What trouble sometimes affects lymphatic glands? About how much lymph is there in the body of a person who weighs one hundred pounds? How much blood?

Health Problems

1. Have you ever known persons to have glandular swellings in their necks? What is the cause of these swellings? The treatment?
2. Explain how physical exercise helps the flow of the lymph.
3. Explain how free movement of the lymph helps recovery from fatigue.
4. Janet was not well, and had become so tired and cross that she could not go to sleep. Her mother gently massaged her, and then she quietly fell to sleep. Explain what the massage did for her.
5. A man who had been bitten on the finger by a rattlesnake immediately cut off his finger. The doctor said this saved his life. Explain how that could be.
6. In what direction is the lymph flowing in the vessels, shown in the drawing on page 103?
7. Explain how a sore on the hand may cause painful "kernels" to swell in the armpit.

CHAPTER XV

BREATHING

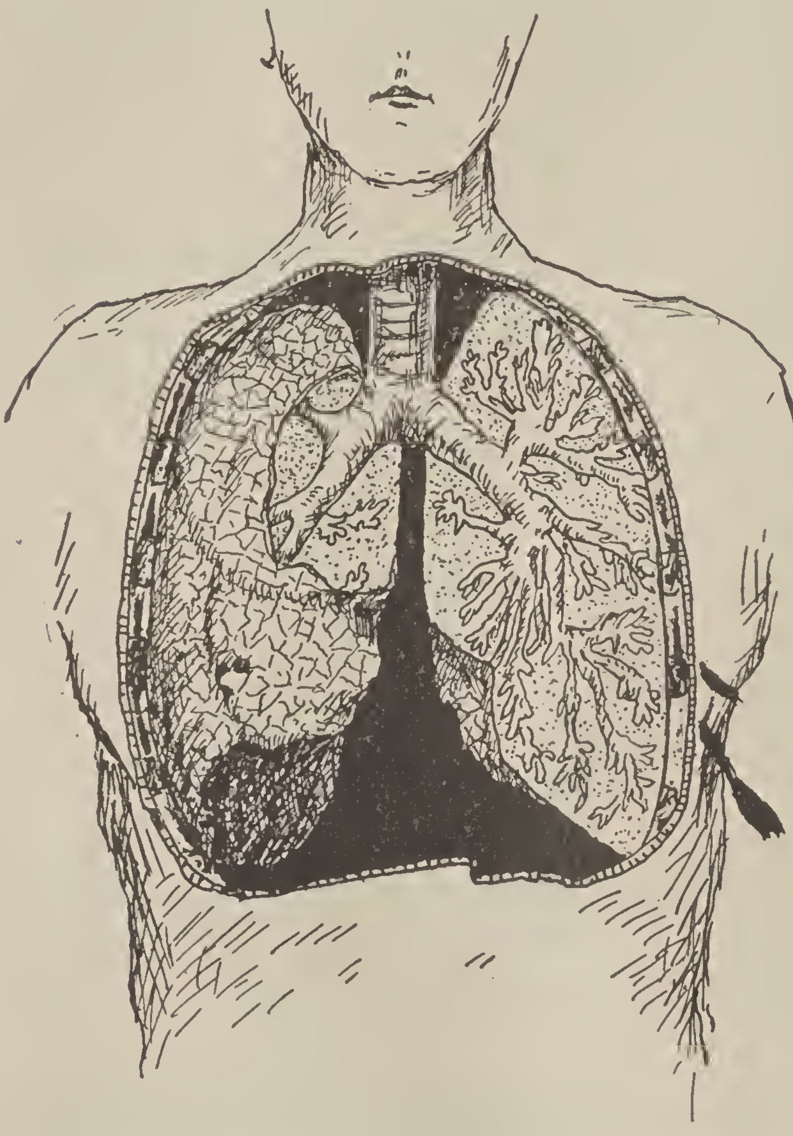
Breathing looks so simple and natural that it seems to require no explanation. Yet breathing is not so simple as it appears when you watch the baby's breast rise and fall with each breath as it lies asleep.

To understand how the lungs work in breathing suppose you make the following tests:

1. Place your hands against your chest while you breathe slowly and deeply several times. Do you find your chest growing larger with each breath you take in and smaller with each breath you give out? Do the ribs lift upward somewhat in front as your chest expands and drop again as it decreases in size?
2. Again, place your hands against your body just below the ribs while you breathe slowly and deeply. Do you find your body contracting and expanding at this point also as you breathe?

How we inhale.—To breathe air into the lungs is to *inhale;* to breathe it out is to *exhale.* The process of breathing is called *respiration.* Let us first see how we inhale.

In order that we may take air into the lungs the lungs must of course expand; the space which they fill inside the chest must become larger. This is partly brought about by the lifting of the ribs by means of muscles which are attached to them. When you eat pork "spare ribs" you are eating the *costal muscles* by means of which the pig's breathing was accomplished. Your costal muscles are attached in similar fashion to your ribs.



The lungs in their chest cavity. The drawing shows the branching of the bronchial tube in the left lung

But the chest cavity grows larger downward as well as outward. Let us see how this is accomplished. Just beneath the lungs and the heart is a muscular floor or partition upon which these organs rest and which separates them from the stomach and other organs of the lower part of the body. This

floor is called the *diaphragm.* The diaphragm is not stretched straight across the body cavity, but is curved upward like a dome.

At each taking in of the breath the muscles of the diaphragm contract and pull the top of the dome downward, so that more room is left for the lungs above. This naturally presses down on the stomach and the other organs below the diaphragm, causing the expansion which you feel in your body at this point when you inhale.

The lungs are very elastic. When the muscles of the ribs and the diaphragm have acted to make the space for the lungs greater, they must at once expand in order to fill this space. The air then rushes in and fills the spaces in the lungs. This is what we mean by inhaling.

How we exhale.—Once the air has got into the lungs it stays like water in a sponge, until it is forced out. To force the air out of the lungs, or exhale, is a very simple matter. The muscles of the ribs relax and allow the ribs to settle back into place; the diaphragm also relaxes and it again takes its dome shape. In this way the chest cavity is made smaller and the elastic lungs will squeeze out the air inside them exactly as we would press the water from a sponge.

A simple experiment will enable one to see just how the muscles work in inhaling and exhaling:

1. Breathe your lungs very full of air and then hold your breath for a few moments. You will note

No trouble about deep breathing here. These Boy Scout campers are taking an early morning exercise in correct breathing

that to "hold the breath" is to hold the muscles of the chest and the diaphragm tense so that the walls are not allowed to settle back and press the air out of the lungs.

2. Now exhale all the air you can from your lungs and again hold your breath, this time with your

lungs as empty as you can make them. You find to "hold your breath" in this way you merely keep the muscles from lifting the ribs or pulling the diaphragm downward. Nor can you breathe in until you have allowed the muscles to make room for the lungs by enlarging the chest cavity.

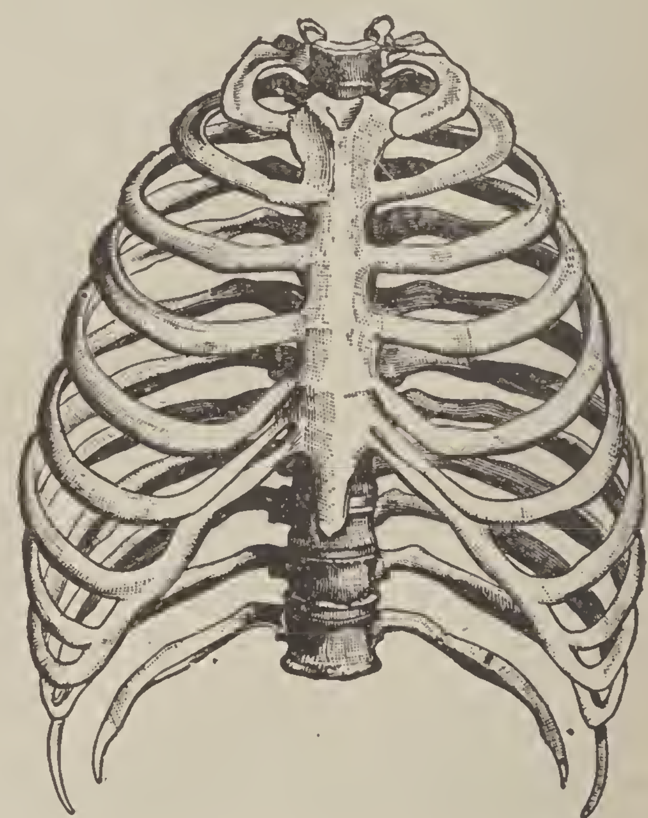
Shallow and deep breathing.—Good breathing requires that the lungs shall have room to expand both outward and downward. The chest must grow larger through the lifting of the ribs and also through the pressure downward of the diaphragm. Shallow breathing requires but little movement of the diaphragm.

Bad habits about breathing.—The very first thing a baby does when it comes into the world is to breathe. It does not have to learn how; it knows. But in spite of this, many people as they grow older need to learn how to breathe; for very few grown persons breathe as well as babies.

1. Few persons breathe deeply enough. It is possible that *you* do not. Suppose you make this experiment: Try breathing rather quick and not very deep, using just the ribs. You will find that you can breathe in this way without feeling any particular discomfort. Now notice occasionally whether you have this habit of shallow breathing.

2. Many do breathe in this way most of the time. Their breathing is shallow; they do not use their diaphragms sufficiently, and therefore the lungs are not expanded to their full extent. The air in the lungs is not properly changed, and this favors the growth of disease germs.

3. It is in little used lung tissue that tuberculosis gets its start. We all need to learn to breathe deep, so that every part of our lungs shall be kept in use.



The natural shape of the chest—larger at the base than the top, thus giving room for the lungs and other organs

Learning to breathe right.—There are two different ways in which we may make sure of deep breathing:

1. We may practise taking ten or twenty deep, full breaths in open air several times each day. But to do this successfully we shall need to have some system about it so that we shall not overlook it. One good way is to practise deep breathing just before going to bed, and the first thing when we get up in the morning—but al-

ways with open windows; also when we first leave the school room at noon or recess time. In deep breathing exercises we should breathe in *slowly*, *steadily*, *deeply* until the lungs are full as they will hold; and then let the air out as slowly as we took it in.

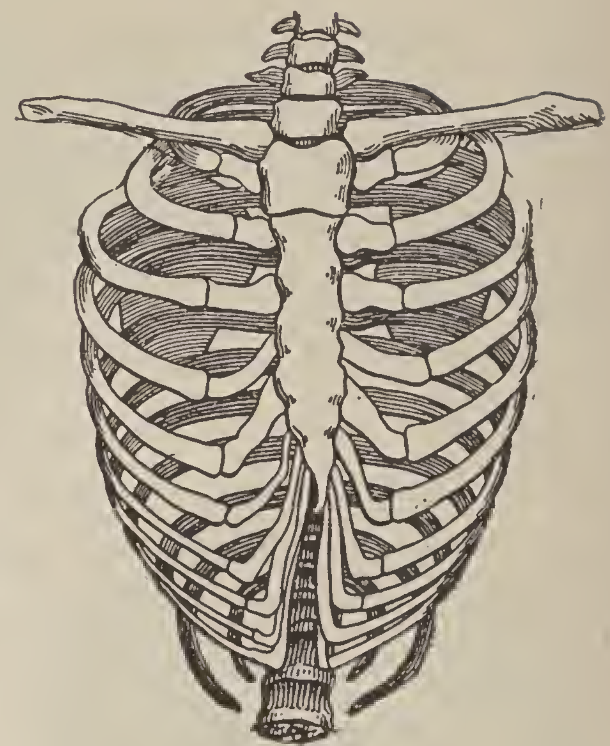
2. We may make sure of deep breathing by taking free, active exercise in the open air. Each day we should have some form of exercise or play that sets our hearts to throbbing and drives our lungs to their fullest capacity.

   Especially is it necessary for those who are shut in most of the day, as pupils in school, to make sure of deep breathing through set exercises and through active work or play out-of-doors.

Clothing that interferes with breathing.—It is impossible to breathe properly when the chest or lower part of the body is bound about with tight clothing. Tight waists, corsets, belts or any other articles of dress which hinder the full and free action of the lungs mean short breath, poor circulation and unused lung tissue.

Posture and breathing.—Probably there are even more people who injure their breathing by cramped postures than by tight clothing. Suppose you try these experiments:

1. Take a glance about your school room and note how many boys and girls are leaning forward in a cramped position over the desk. Also how many have slouched down in the seat so that the body is bent in a curve.



The unnatural shape of the chest caused by tight corsets. The organs are cramped and unable to do their full work

2. Now while you are sitting upright (standing would be better) in a good position breathe deep, and at the same time watch the feeling of expansion in your chest. Next, sit bent forward cramped over your desk and while in this position try breathing deep. Do you get full chest expansion and deep breathing? Then try sliding down in your seat with your body cramped and curved, and again try filling your lungs very full of air. How do you succeed? What do you conclude about good posture and deep breathing?

3. When you go to bed, try the same experiment of deep breathing, (1) while lying easily on your side with the body straight, and (2) with your

body curled up in a ball. Which position do you conclude is best for sleeping?

Questions to answer.—Describe an experiment by which you can watch your chest expand and contract as you breathe. What does it mean to inhale? What does it mean to exhale? What longer word is sometimes used for the act of breathing? Explain the means by which the chest cavity is made larger each time we inhale. How is the cavity made smaller when we exhale? What is meant by shallow breathing? What is meant by deep breathing? Why should one learn to breathe deep? Explain two different ways in which we can make sure of deep breathing. Tell how tight clothing interferes with breathing. Explain how a stooped or cramped posture interferes with good breathing.

Health Problems

1. Point out each organ or part that has to do with breathing. Which of these are especially subject to disease?
2. Explain the act of coughing; of sneezing. What causes each?
3. Demonstrate the difference between shallow and deep breathing.
4. Where does the mucous come from which you cough up when you have a cold? Why does the nose run?
5. Try deep breathing while you are sitting stooped over. What do you conclude?
6. How much of your lung tissue do you suppose you fail to use in your breathing?

CHAPTER XVI

THE WORK OF THE LUNGS

The lungs are the lightest for their size of any organs of the body. They easily float in water. The lungs of animals are often spoken of as "lights," because they weigh so little.

It is because of the large number of air cells they contain that the lungs are so light in weight. In fact, the lungs are little more than great bags arranged to hold a considerable quantity of air and at the same time accommodate many blood-vessels. We can best understand the work of the lungs by first taking a look at their structure.

Air tubes leading to the lungs.—If you will feel with your finger and thumb at the front of your throat you can trace a rough, ribbed tube which leads from the voice box down into the chest. This is the windpipe, or *trachea.* Just back of the top of the breast bone the trachea divides into two branches, one of which goes to each lung. These two branches are called *bronchi*, or bronchial tubes.

The bronchial tubes keep on branching and rebranching after they enter the lungs, until very fine

air tubes have reached to every part of the lungs. Each of the little tubes finally ends in a cluster of tiny bulbs, called *air cells.*

The whole arrangement of air tubes leading into the lungs very closely resembles an inverted tree, with hollow trunk, hollow branches and hollow twigs, and with hollow bulbs instead of leaves.

Air cells of the lungs, greatly magnified. The drawing shows the blood capillaries surrounding the one on the right

The air cells.—It is in the air cells that the really important work of the lungs is done; for it is here that the air comes in contact with the blood and that the exchange of carbon dioxide for oxygen takes place.

Each air cell is a very small chamber, but they number many thousands. So numerous are they that if the walls of the air cells from the lungs of an adult could all be spread out together they would cover a surface of about ten yards square.

The walls of the cells are of very thin tissue, and imbedded in this tissue are found numberless blood capillaries. All the blood of the body is pumped by the right ventricle through the capillaries around the

air cells once in less than a minute, hour after hour throughout our lives.

The exchange between air and blood.—The oxygen of the air and carbon dioxide are both gases that pass freely through the walls of the air chambers. Therefore when the blood comes surging into the lungs from the heart laden with carbon dioxide from the tissues, the exchange is quickly made. The oxygen passes through the walls of the air chambers to the red corpuscles of the blood, and the carbon dioxide passes out from the blood to the air cells.

This exchange of carbon dioxide for oxygen is called purifying the blood. When the blood has handed its impurities over to the air cells and taken on a new supply of oxygen it is again ready for another tour of the body.

Changing the air in the cells.—Try exhaling the air from your lungs as completely as you can, until you would think there was hardly a particle left. Yet, try as you will, almost half of the entire amount contained by the lungs remains in the air chambers and can not be forced out by breathing.

In fact, in ordinary breathing only about one-tenth of the air in the lungs is changed with each breath. As fresh air is inhaled it is mixed with the air already in the lungs, the change from stale air to fresh air being gradual.

Fresh air for all the cells.—If only about one-tenth of the air in the cells is changed with each breath, it is clear that of the remaining nine-tenths, some must remain unchanged for a considerable time.

Naturally the changes from stale to fresh air will go on most rapidly in the air chambers most used. If, because of tight clothing, bad postures or shallow breathing, we use only a portion of the lungs, the air in the little used cells remains impure.

The little used air cells make good homes for the germs of tuberculosis. The doctors find that the disease usually begins in the parts of the lungs which are least used. The germs can work in idle cells undisturbed.

Here are two important points to remember and put into practise:

1. Little used lung tissue is always a source of danger. It is the natural home of the germs of colds, pneumonia and tuberculosis.
2. To get the full use of our lungs and help make them safe from disease we must keep all the air cells employed. We must give the lungs plenty of room to breathe, and supply them with an abundance of fresh, clean air.

How the lungs are protected against dust.—If you will stand before a mirror and carefully investigate your nasal passages you will discover that they are lined with small hairs. If you could examine the

lining of the air tubes that lead to the lungs you would find them covered in like manner with thousands of tiny hairlike projections called *cilia*.

The moist surfaces of the air passages catch the particles of dust, or any other foreign substance, and, by a peculiar wavelike motion toward the outside, the cilia drive the intruder out of the lungs. The hairs at the beginning of the nasal passages also serve to keep dust, small insects and the like from getting into the lungs.

Dust an enemy of the lungs.—Dust is always an enemy of the lungs. The workers in certain dusty trades, such as stone cutting, grinding on emery wheels, manufacturing cement, etc., show a much higher tendency to lung diseases than the workers in dustless trades. Household dust and school room dust, especially in sunless rooms, is always to be avoided, while street dust may at times be quite dangerous.

The first count against dust, as we learned in Book One, is that it carries bacteria. Millions of germs ride into the lungs on the dust particles breathed in as we work in a dusty place or sit in a dusty room. The great majority of these bacteria have already been killed by the sunlight; the most of those that are alive are harmless, but there is always the danger that there may be among them the living germs of disease.

When dust of the heavier kinds, such as that coming

from stone, emery, or coal, is breathed in in large quantities the cilia find it impossible to drive it all out again. The result is that these particles accumulate in the air cells of the lungs and interfere with their work.

Doing away with dust.—Every one should declare war on dust. Many factories are now being equipped with machines that suck the dust up and drive it away from the workers. In other occupations workmen breathe through gauze, which strains the dust out of the air. Streets and roads are being oiled, and pavements washed to keep down the dust and save the lungs.

We should be no less careful in our homes. Plush covered furniture and heavy curtains catch too much dust to be hygienic. Rugs which can be taken out and beaten are better than carpets. Carpet-sweepers are better than brooms, and vacuum cleaners better than either. Feather dusters and dry dusting-cloths should give way to oiled or damp dusting-cloths. Dust should not be allowed to gather on the tops of cupboards, under furniture or in any unused corner, for every passing breeze whips it up into the air and it is soon lodged in the cells of our lungs.

Lung power and physical strength.—One day I happened in at the gymnasium where a squad of college football men were being examined and measured

by their trainer and coach. In the course of the testing each man stepped up to an interesting instrument called the *spirometer*, and, putting his lips to a mouthpiece, blew with all his might into the machine. A dial measured the number of cubic inches of air he had been able to force from his lungs.

The appearance of the outer surface of the lungs

The trainer told me that if he could have but *one* measure of man's physical power and endurance he would test his lung capacity. "For," he said, "no man's muscles or nerves can be better than his lung power." And that is in large measure true, although a man's endurance depends also on his nervous system and on his heart. One might as well try to run his furnace without a draft to let the oxygen in to the fire as to try to run his body without lung capacity enough to supply oxygen for his tissues.

Increasing our lung power.—From the lessons we have learned it is clear what we must do to have good lung power: *We must train the muscles by which we do our breathing.*

The muscles by which we lift the ribs and expand the chest when we inhale can be strengthened by proper exercise so that they will be able to make the

chest cavity larger and give the lungs more room. The muscles of the diaphragm by which the chest space is made deeper when we breathe can also be trained to greater power.

These muscles, like all other muscles of the body, can be developed only through their proper use. These are the rules to be followed:

1. Keep your chest up, head erect, body straight. Treat your lungs right; give them plenty of room and an abundance of fresh air.
2. Train yourself to exercise properly. Play hard, work hard, get enough rest. Learn how to breathe, and then form the habit of breathing right while you work, play, rest or sleep.

Interesting things to do.—1. If you have the use of a spirometer, practise blowing into it several times a week, keeping a record of your improvement. Note which members of the class make the best showing in lung power, and which show the greatest improvement from week to week.

2. While the spirometer tests are going on have your chest measure taken. Do not be satisfied unless you are showing improvement.

Questions to answer.—Why are the lungs so much lighter than muscle? What is the air tube that leads from the back of the mouth to the lungs? Explain the branching of this tube. Describe the air cells

of the lungs. What important work takes place in the air cells? How does the oxygen get from the air into the blood, and how does the carbon dioxide get from the blood out into the air cells?

What proportion of the air in the lungs is it impossible to drive out by exhaling? What proportion of all the air in the lungs is changed at each breath? Why should we make sure to use all the air cells in every part of our lungs? What are the *cilia?* Explain how the cilia work to keep dust from getting into the lungs. Give two ways in which dust is bad for the lungs. How are factories trying to protect the workers from dust? What measure should we take in our homes to do away with dust? Tell what the machine called a *spirometer* is for. Why is lung capacity so important a thing for an athlete? Tell how we may increase our lung power.

Health Problems

1. What trades or occupations are especially dangerous to health because of the dust?
2. What are some of the devices used to protect workers against dust?
3. Pittsburgh and Chicago are known as smoky cities. What do you suppose is the color of the lungs of people who live constantly in these cities?
4. Judging from your usual posture in sitting, standing and working, and from your habits of breathing, how much lung tissue do you think you have which you do not use?

CHAPTER XVII

NATURE'S FOOD LABORATORIES

A friend of mine recently gave me a great treat. One day he invited me to go with him through an automobile factory where he is employed and see how automobiles are made.

We watched the process step by step. We saw men take the steel, the wood, the rubber and other materials and work upon them. Part by part we traced the automobile as its various pieces were passed through roaring, buzzing machines, until at last they came out complete and ready to go into the finished car.

Then we followed these parts into the assembling room, where they are put together and the car made ready to run. Last, we got into one of the beautiful finished cars and were carried like magic, gliding over the city streets. Ever since that day I have felt like taking off my hat to a great factory every time I pass by one. For it seems so wonderful that the raw material from the forest and the mine can, by the skilful work that goes on in the factory, be made into a machine so lifelike as an automobile!

The plant laboratories.—In this lesson I want to tell you about a kind of factories we all know about in a general way, and which are even more wonderful than any automobile factory. The factories I have in mind are small, but they exist all about us by thousands, yes, by millions. They continue their work day and night, year in and year out. The factories I mean are the *plants*, nature's food laboratories, on which all men and animals depend finally for their food supply.

Let us begin our story at the beginning, and we shall soon come back to the factory question. We have already learned in BOOK ONE that all of the body's energy comes from the food we eat. We have seen how the body can no more secure energy for its movements and its heat without burning up food supply than the locomotive can find energy to pull its load without burning the coal to supply steam.

Food energy and body energy.—As we look at the food—the potatoes, the bread, the meat—placed on our table for a meal, it seems strange that it should contain such a store of energy. The food appears to be lifeless and dead; it may even have been cooked and the cells of which it is composed been destroyed. Who would dream that such substances could provide the heat and driving power for the body or build up its tissues! Yet we know that our food contains energy locked up in its cells just as coal contains energy stored away in its molecules.

A still more astonishing thing is this: The chemist tells us that the tissues of our bodies have in them no element or substance which is not also found in the air we breathe, the water that fills our lakes and rivers, and the soil under our feet. And yet more wonderful, he tells us that the material of which our bodies are made *actually first comes from the air, water and soil;* and that the energy which the body uses for its heat and its work *originally comes from the sun!*

Making the food energy ready for the body.—The puzzling question is how the body can gather up and make use of the substances that exist in the air, the soil and water. Or how it can appropriate energy coming from the sunlight.

For our bodies are made up of living cells; and no animal in the world is able to transform the lifeless food substances from the form in which they are found in soil, air or water into living tissues. No animal is able to take the energy needed by its body directly from the sunlight. There must first be some way of making these substances over, and fitting them for the use of living bodies.

The work of the plants.—It is at this point that the plant laboratories come in. Plants have the power to take and use the energy *directly from the sunlight.* They are able to gather up the food elements *from the*

soil, the air and water, and work them over in such a way that these substances are built into the living cells of the plant.

Plants are therefore chemical laboratories, busy at work preparing food for animals and men. The plants

These Girl Scouts are making the cow furnish them food, but the cow was obliged first to secure this food from plants

get the energy by which they carry on their work directly from the sunlight in which they grow. By the use of this energy they are able to pick up their food from the soil, the air and water, where it has been prepared for them by the myriads of useful bacteria of the soil and water. Thus they build up their own growth. When this is accomplished men or animals can eat the

plants, and so secure the materials they need for their bodies.

Our dependence on plants.—If for any reason all the food plants should die or fail for a time to do their work, every animal on the face of the earth would soon die of starvation. So we cultivate plants. We go out into our gardens and plant our potatoes, beans and peas; we go out into the fields and sow our wheat. We give them rich soil, plenty of water, air and sunshine. In a few weeks or months the plants we have tended will have gathered up rich treasures of food material which we could never obtain without their help.

No wonder then that we try to improve our science of agriculture! No wonder that we study gardening and fruit growing! No wonder that we fight weeds, bugs and other enemies of our food plants! For whether we eat animals or plants, it matters not; we must finally go back to nature for our food. And we must have the plants to make our food ready for us.

These two important facts are worth remembering:

1. All the substance that goes to make up our bodies—the materials that build our muscles, bones, blood, and even our brains—first exists as inanimate matter in earth, air and water. And all the energy the body uses first comes from the sunlight.
2. This lifeless material must be gathered by grow-

ing plants, and by them made over into living tissues. We may then either eat the plants, or eat the flesh of animals that live upon the plants.

Interesting problems and experiments.—1. Set a growing plant away in a dark place for a week,

These boys have been helping nature prepare their food in plant laboratories

then note its appearance. Does it look healthy? Has it made a good growth? The poor showing made by the plant is due to the fact that it lacked the energy supplied by sunlight. Without this energy it was unable to take and use sufficient food from the soil, the air and water. A plant starves when away from sunlight. Since the

plants store up the energy of sunlight for us, men can live for months in the dark and have good health if their food is good.

2. On some near-by field notice the small, spindling stalks of grain growing on a hilltop; and note also the larger, stronger stalks produced on the lower ground. The difference is caused by the rains carrying the food elements of the soil from the hilltop to the plain below. The plants on the hilltop are suffering for want of food; those lower down have good nutrition. Good and poor nourishment will have a similar effect on people.

3. Find some wet place in a field of grain or a garden where the water has been standing about the roots of the plants for several days following a rain. Explain why the plants look yellow and unhealthy (remember the plant's need of air). Is air as necessary to our life as to the life of plants?

4. Let a house plant go without watering for a number of days, and then note its appearance. The plant has become thirsty. Do thirsty plants thrive? Is plenty of water as necessary to your growth as to the growth of a plant?

Questions to answer.—Why are plants sometimes called *laboratories* or *factories?* Where does the body's energy come from? Where does the food we eat

obtain its energy? Is the body able to gather its food energy directly from the air, the soil and water? Explain. What important work do plants do for men and animals? Explain what would happen to all animals in the world if plants should stop gathering energy and making it over into food.

Health Problems

1. You can take nuts, corn, olives and most other foods and extract from them oil which can be burned to produce heat and light. Where do the heat and light originally come from?
2. Why is it necessary to apply some form of fertilizer to soil which is constantly producing crops?
3. Why is it that growing animals and persons get hungry oftener than those who have their full growth?
4. Cows' milk has in it a great deal of sugar. Where does the sugar come from?
5. China suffered a great famine in 1920–21 in which millions of people died of starvation. There was plenty of air, sunshine and soil. What was lacking which is necessary to produce food from the soil?
6. Make a list of ten of the world's chief food plants. What ones of these are raised in the United States? In your state? In China? In Russia? In England?
7. Make a list of ten animals which are most important in supplying our food. What ones of these are produced in the countries just mentioned?
8. Why do we not have famines in our country?

CHAPTER XVIII

KINDS OF FOOD REQUIRED

A good way to begin the study of this lesson will be to write down the names of every different kind of food you have ever eaten. You will have in your list many kinds of vegetables, fruits, meats, cereals, nuts, dairy products, candies and so on. Besides all these there are no doubt many other foods which you have never yet tasted.

In fact, if one should undertake to name all the various articles of food commonly used, he would have a list containing several hundred different varieties. Yet, aside from certain minerals and water, all these foods consist of only three different kinds of substances. These are: (1) *proteins*, (2) *carbohydrates*, and (3) *fats*.

Three kinds of food material.—Proteins, carbohydrates, and fats are the three great classes of foods we must have in order to build up the tissues of our bodies, and supply the fuel and energy required.

Nearly every kind of food we eat contains some proportion of all three of these substances. Yet some foods have more of one, and others more of another. For

example, lean meats and the white of eggs are almost pure protein and water. Bread, sugar and starch are principally carbohydrates. Butter, olive oil and cream consist chiefly of fats.

Protein foods.—The proteins of our food were once the protoplasm of the living plants and animals from which the food comes. Since the growth and repair of our bodies depend on these proteins, a certain amount of protein food is therefore absolutely necessary. If the body is not supplied with the needed protein, its cells will waste away and die. You may feed a growing person all you choose of sugar, starchy foods, and fats, but if the food contains too little protein, his growth will be hindered and he will be sure to be under size.

Carbohydrates and fats.—Carbohydrates and fats are the *fuel foods* of the body; they supply the heat and other forms of energy. Besides using them directly as a fuel the body has the power to store them up in layers of fat beneath the skin, or around the different organs. To do this it must of course first change the surplus carbohydrates over into fat. When, therefore, we eat more fuel foods than the body requires, the surplus is in this way stored up for future use. We say that a person who is thus storing up body fuel is growing fat.

Stored up fat has several different uses:

1. It helps retain the body's heat. This explains why a fat person usually can stand more cold than one who is thin.
2. Fat provides padding, or cushions, which help protect the organs of the body from injury. A reasonable amount of fat also adds to one's appearance.
3. During a time of sickness or when one is working very hard and so using up energy faster than it is being supplied, the body can draw upon its supply of stored fat and use it for fuel. It is like having an extra bin of coal in the basement to use in an emergency.

The uses of fat.—One who is drawing upon his reserve of fat always loses weight. The sunken appearance of the eyes, when one has been ill or is severely exhausted, is caused by the using up of the cushions of fat which lie just behind the eyeballs. Football players often lose as much as five pounds in weight during a single game. The most of this is perspiration but some is fat which is used up rapidly by the hard exercise.

It does the body no good to gather too much fat. Fat adds nothing directly to one's strength. Fat persons are usually not quite as healthy as those of average weight. Beyond a reasonable supply, fat may even

hinder our movements, injure our appearance, and interfere with the work of the heart, lungs or other organs.

When one grows too fat.—I met a man this morning who is so fat that he must be uncomfortable. He wheezes when he hurries to catch a car. He waddles when he walks. His clothes look to be too small for him. His appearance would be much more attractive if he were to lose twenty-five or thirty pounds of fat.

How does one grow too fat? Some fat persons are not quite well and can not use all the fat of their food. It therefore tends to accumulate in their bodies. But for most persons there are two reasons why they get fat: they may eat more than the body requires, or they may exercise so little that the body uses up but little of its fuel, and so allows the surplus to accumulate as fat. If one who is otherwise well wants to reduce his surplus fat he can do it in either one of two ways: (1) eat less, especially of fat-producing foods, or (2) exercise more.

The following table gives a few of the more common foods containing a large proportion of one of the three chief food materials. Some foods, as milk or eggs, have a good supply of two or more food substances:

Foods rich in Protein	Foods rich in Fat	Foods rich in Carbohydrate
Lean meats	Fat meats	Most vegetables
Fowl	Eggs	Bread
Veal	Nuts	Potatoes
Fish	Butter	Sugar
Eggs	Cream	Milk
Skim milk	Cheese	Fruits
Beans	Milk	Oysters
Peas	Most pies	Peas
Lentils	Doughnuts	Beans
Cheese	Cream soups	Peanuts

Bulky foods.—Not only should our dietaries consist of the right food elements, but they should also possess considerable bulk. Many of our best foods are too concentrated. It is possible to compress enough meat and vegetables for a day's rations into a very small package. Food in this form, however, does not serve its full purpose.

We need daily a considerable quantity of foods that contain coarse, woody fiber. Such fruits and vegetables as lettuce, celery, spinach, asparagus, cabbage, cauliflower, corn, beets, tomatoes, berries, etc., supply us the bulk and fiber we require.

Hard foods.—It is necessary also that some proportion of our foods consist of hard substances that require cutting and grinding by the teeth. Hard

cereals, crusts of bread, hard biscuits, hard fruits, fibrous vegetables and nuts are a very important part of our diet.

Hard foods are desirable because they require chewing and this helps to preserve the teeth and keeps them in good condition. Chewing also insures a flow of saliva in the mouth and of gastric juice in the stomach.

Dry and crusty bread is therefore preferable to soft fresh bread or rolls, such as many people like. The physicians tell us that the Filipinos had perfect teeth so long as they lived on hard, coarse foods. But when they changed to the soft foods used by the more highly civilized nations, their teeth quickly began to decay.

1. The table of foods which follows is only for reference. Look it over carefully and make a list:
   (1) Of the ten foods containing the largest proportion of protein;
   (2) Of the ten foods containing the largest proportion of carbohydrates;
   (3) Of the ten foods containing the largest proportion of fats;
   (4) Of the ten foods containing the largest proportion of water.
2. Compare your lists with the table given on page 139. Do they agree?

Per Cent. of Food Substances in Different Articles of Diet:

	Protein	Carbo-hydrate	Fat	Water	Mineral Matter
Almonds	21.0	17.3	54.9	4.8	2.0
Fresh asparagus	1.8	3.3	0.2	94.0	0.7
Bananas	1.3	22.0	0.6	75.3	0.8
Dried beans	22.5	59.6	1.8	12.6	3.5
Roast beef	22.3	....	28.6	48.2	1.3
Bread	8.9	56.7	4.1	29.2	1.1
Butter	1.0	....	85.0	11.0	3.0
Fresh cabbage	1.6	5.6	0.3	91.5	1.0
Sponge cake	6.3	65.9	10.7	15.3	1.8
Cheese	25.9	2.4	33.7	34.2	3.8
Chicken	21.5	....	2.5	74.8	1.1
Green corn	3.1	19.7	1.1	75.4	0.7
Oyster crackers	11.3	70.5	10.5	4.8	2.9
Fresh cranberries	0.4	9.9	0.6	88.9	0.2
Egg	13.4	....	10.5	73.7	1.0
Wheat flour	13.8	71.9	1.9	11.4	1.0
Gingerbread	5.8	63.5	9.0	18.8	2.9
Macaroni	13.4	74.1	0.9	10.3	1.3
Leg of mutton	25.0	....	22.6	50.9	1.2
Milk	3.3	5.0	4.0	87.0	0.7
Brazil nuts	17.0	7.0	66.8	5.3	3.9
Oatmeal	16.1	67.5	7.2	7.3	1.9
Fresh oysters	6.0	3.3	1.3	88.3	1.1
Peanuts	25.8	24.4	38.6	9.2	2.0
Dried peas	24.6	62.0	1.0	9.5	2.9
Green peas	7.0	16.9	0.5	74.6	1.0
Potatoes	2.5	20.9	0.1	75.5	1.0
Squash pie	4.4	21.7	8.4	64.2	1.3
Apple pie	3.1	42.8	9.8	42.5	1.8
Tapioca pudding	3.3	28.2	3.2	64.5	0.8
Dried prunes	2.1	73.3	....	22.3	2.3
Rice	8.0	79.0	0.3	12.3	0.4
Canned salmon	21.8	....	12.1	63.5	2.6
Fresh tomatoes	0.9	3.9	0.4	94.3	0.5
Veal	21.2	....	8.0	70.3	1.0
Soft-shell walnuts	16.6	16.1	63.4	2.5	1.4

Questions to answer.—What can you tell about the number or variety of foods we commonly eat? Into how many classes may all these different foods be divided? What are the names of the three groups of foods? What is the work done by *protein* foods in the body? What do *carbohydrates* and *fats* do for the body? Give several uses of stored up fat. Tell why or how a person becomes fat. What happens to the fat of the body when one becomes thin, as in sickness? Name several different foods rich in each of the three food qualities, *protein*, *fat*, and *carbohydrate*. Why do we need bulky foods? Why do we need hard foods?

Health Problems

1. Since there is no place for body fat to come from but the food we eat, and since the body stores as fat only the food not required for other uses, what would you advise a person to do in order to keep from getting too fat?
2. From what foods are you securing most of the proteins of your dietary? Most of the fats? Most of the carbohydrates?
3. If you were obliged to get along on three or four foods only, what ones should you choose (not because you like them best, but for their food elements)?
4. Suppose your food should not contain enough fat, what would be the effect? Enough protein? Enough carbohydrates?
5. Do you think you live on a well balanced dietary? Give reasons for your answer.

CHAPTER XIX

MEASURING FOOD VALUES

If we should be asked how much we ate for dinner, we might tell how many slices of bread, how many eggs and how many helpings of potatoes we had.

The scientists have invented a more accurate way, however, of measuring the food we eat. Just as distance may be measured in yards, wheat in bushels, and temperature in degrees on a thermometer, so the amount of food we require may be measured in *calories*.

Measuring food in calories. — A *calory* (kal′o rĭ) is the amount of heat required to raise the temperature of one litre (practically one quart) of water, one degree centigrade. It is possible to measure food values in calories, because the body uses most of its food as fuel for producing heat and other forms of energy.

Instead, therefore, of saying that a person needs so many slices of bread, so many potatoes, or such and such a quantity of meat for a day's ration, we may state that he requires a certain number of *calories*. One may secure the required number of calories from a great variety of foods, but he must have enough calories for fuel or his body will suffer.

The number of calories we require.—Our bodies do not require the same amount of food under all conditions. Since the chief use of food is to act as fuel for the body, it is clear that weather will have something to do with the quantity of food we need. You have perhaps noticed that you get more hungry in the winter than in the summer. This is on the same principle as that the furnace requires more coal in cold weather than in warmer weather. The body requires more fuel to heat it when the air about us is cold. Again you have noticed that when you are working or playing hard, you get more hungry than if you are not exercising. This is on the same principle as that the locomotive, when running sixty miles an hour, will require more coal than when running thirty miles an hour. The body uses up more fuel energy when it is active than when it is at rest.

Careful experiments have shown that a man of average size, who is engaged in such work as a trade, or farming, requires from 2,500 to 3,000 calories of food a day. Women require somewhat less food than men, because they are smaller, and also because their work is generally not quite so active as the work of men.

Boys and girls of twelve and thirteen years of age, who are having plenty of exercise, need about 2,000 calories of food a day. This means that your body is daily using up as much energy as would be required to bring eleven quarts of water from freezing to the boiling point.

The value of different kinds of food.—When we speak of a certain kind of food being nourishing, or strengthening, we mean that it will supply a large amount of food energy to the body. A certain amount of it will yield a large number of calories. Some foods are much more concentrated than others, hence we need a smaller amount of them.

An interesting comparison of different foods can be shown in the following way: Suppose you were to eat but one single kind of food for a day, and suppose you were to take just enough to supply 2,500 calories. Suppose that for the first day you decided to eat nothing but butter; *fourteen ounces* of butter would supply your 2,500 calories. The next day take almonds or walnuts. You would then need *one pound*. Suppose on the third day you were to choose lettuce. You must have *thirty-five pounds* of lettuce to obtain 2,500 calories of food energy.

Of course no one would think of eating in this way, but such an illustration makes it clear why we eat a larger quantity of certain foods than we do of other foods. The following table is not for you to commit to memory, but to look over carefully and compare the amount of nourishment in different kinds of foods. Remember that the weight given for each food is what you would have to eat if you chose that food alone from which to secure the 2,500 calories you would require each day if you were full grown.

The following table shows the amount of each food that would be required to secure from it alone 2,500 calories:

Butter	14	ounces
Almonds or walnuts	1	pound
Smoked bacon	18	ounces
Cheese	1 ½	pounds
Raisins, dried figs or dates	2	pounds
Bread	2 ½	pounds
Beef	3	pounds
Baked beans	5	pounds
Eggs (about 38 eggs)	5	pounds
Bananas	7	pounds
Potatoes	8	pounds
Fish	7 to 13	pounds
Milk	9 ½	pounds
Apples	10 ½	pounds
Oysters	13	pounds
Onions	14	pounds
Cabbage	21	pounds
Tomatoes	30	pounds
Lettuce	35	pounds

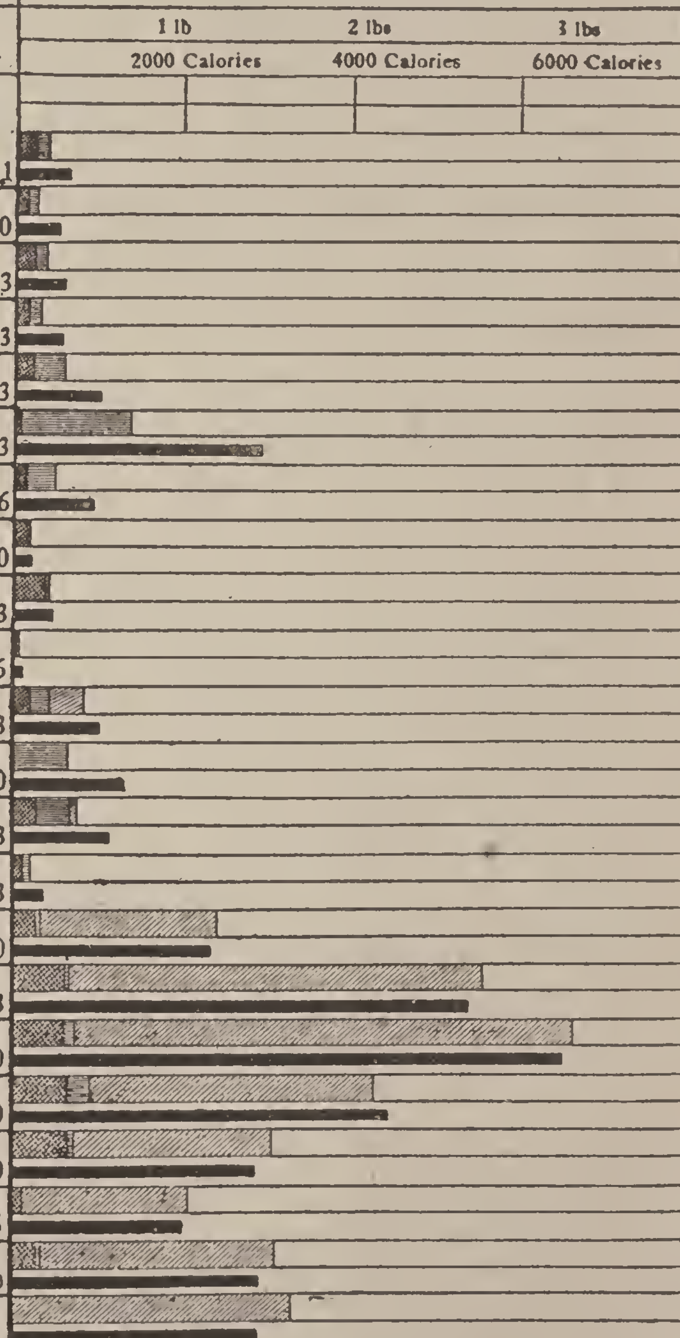
(From Bulletin 29, U. S. Dept. of Agriculture.)

This interesting table shows that to get the amount of fuel which fourteen ounces of butter would give,

Protein. Fats. Carbohydrates Fuel Value

FOOD MATERIALS	Price per pound Cents	20 cents will buy lbs.
Beef, round	28	.71
Beef, sirloin	40	.50
Beef, shoulder	24	.83
Mutton, leg	32	.63
Pork, Loin	24	.83
Pork, salt, fat	24	.83
Ham, smoked	36	.56
Codfish, fresh, dressed	20	1.00
Codfish, salted	14	1.43
Oysters, 70 cents quart	36	.56
Milk, 12 cents quart	6	3.33
Butter	50	.40
Cheese	32	.63
Eggs, 24 cents dozen	32	.63
Wheat bread	10	2.00
Wheat flour	6	3.33
Corn meal	5	4.00
Oat meal	8	2.50
Beans, white, dried	10	2.00
Rice	16	1.25
Potatoes 1.20 bushel	2	10.00
Sugar	12	1.67

Pounds of nutrients and calories of fuel value in 20 cents worth



This table shows the relative value of different foods at the prices usually charged. It also indicates the amount of the different food elements in each kind of food

one would have to eat more than three dozen eggs; or drink nine and a half pounds of milk; or eat eight pounds of potatoes; or thirteen pounds of oysters; or thirty pounds of tomatoes.

It is easy to see from this comparison why it is better to have a varied diet. Butter gives its fuel in too concentrated a form, while most vegetables, and even oysters, would be required in too great quantities if eaten alone.

Interesting questions and problems.—1. Why does an active boy or girl get more hungry than an adult?

2. Which will require more food, a man who is digging a ditch or a man who is working in a store? Explain why.

3. What difference should we make in the amount of fats and carbohydrates in our diet as the season passes from winter to summer? What difference in the amount of food we take? Why do the Esquimos like whale blubber and other fat meats, while people who live in the tropics prefer foods containing less fat?

4. Study the table that follows and estimate the number of food calories you are eating from day to day. Make a list of the articles of food you eat for one day, and estimate the number of calories you receive from each kind of food.

The quantities given for each of the following foods will yield 100 calories.

Name of food	Portion required for 100 calories	Weight required for 100 calories
Beans, canned	Small side dish	2.66 ounces
Beans, string	Five servings	16.66 ounces
Beets, cooked	Three servings	8.7 ounces
Sweet corn	One side dish	3.5 ounces
Onions, cooked	Two large servings	8.4 ounces
Peas, green	One serving	3. ounces
Peas, canned	Two servings	6.3 ounces
Potatoes	One good sized	3.5 ounces
Tomatoes, fresh	Four average sized	15. ounces
Apples	Two	7.3 ounces
Bananas	One large	3.5 ounces
Oranges	One very large	9.4 ounces
Peaches	Three average size	10. ounces
Beef, round, fat	Small serving	1.3 ounces
Beef, round, lean	Large serving	2.2 ounces
Lamb chop	One small	.96 ounces
Pork, roast	Small serving	1. ounce
Cake, chocolate layer	Half ordinary piece	.98 ounces
Doughnuts	Half a doughnut	.8 ounces
Pie, apple	One third ordinary piece	1.1 ounces
Pudding, brown betty	Half ordinary serving	2. ounces
Pudding, cream rice	Very small serving	2.65 ounces
Bread	Ordinary thick slice	1.5 ounces
Corn flakes, toasted	Ordinary cereal dish full	.97 ounces
Oatmeal	One and a half servings	5.6 ounces
Rice	Ordinary cereal dish full	3.1 ounces
Shredded wheat	One biscuit	.94 ounces
Butter	Ordinary pat, or ball	.44 ounces
Milk, skimmed	One and a half glasses	9.4 ounces
Milk, whole	Small glass	4.9 ounces
Sugar, granulated	Three teaspoonfuls	.86 ounces
Eggs	One large	2.1 ounces

—Adapted from Fisher and Fisk, *How to Live*.

Questions to answer.—What is the name of the measure used for food values? What is a calory? Why does one need more food in winter than in summer? Why does one need more food when he is at work than when he is idle? About how many calories of food does a full-grown person engaged in moderate work require in a day? Name several foods a small quantity of which will supply many calories. Name other foods a large quantity of which is required to supply enough calories. Explain why it is better to have a varied diet than to eat all one kind of food. How many calories of food should a boy or girl of twelve or thirteen years eat each day?

Is your weight proportioned to your height?

(Indoor clothes, but without shoes)

BOYS			GIRLS		
Height Inches	*Average Weight for Height Pounds*	*10% Underweight Pounds*	*Height Inches*	*Average Weight for Height Pounds*	*10% Underweight Pounds*
52	65.8	59.2	52	63.8	57.4
53	68.9	62.0	53	66.8	60.1
54	72.0	64.8	54	70.3	63.3
55	75.4	67.9	55	74.5	67.1
56	79.2	71.3	56	78.4	70.6
57	82.8	74.5	57	82.5	74.3
58	87.0	78.3	58	86.6	77.9
59	91.1	82.0	59	91.1	82.0
60	95.2	85.7	60	96.7	87.0
61	99.3	89.4	61	102.5	92.2
62	103.8	93.4	62	110.4	99.4
63	108.0	97.2	63	118.0	106.2
64	114.7	103.2	64	123.0	110.7
65	121.8	109.6	65	130.0	117.0
66	127.8	115.0	66	137.0	123.3
67	132.6	119.3	67	143.0	128.7
68	138.9	125.0	68	146.9	132.2

CHAPTER XX

WHY WE COOK OUR FOOD

Yesterday I sat in a restaurant near three men who were ordering their dinners. One man asked for roast beef, another for beef stew, and the third for a broiled steak. They all ordered beef, but each wanted his beef cooked in a different way.

When it came to potatoes it was the same. The first man ordered his potatoes baked; the second asked for his hashed brown; the third wanted his mashed. Again the same food, but three different ways of cooking it.

The importance of good cooking.—The cooking of food is one of the most important arts known in our civilization. Not only do most girls learn to cook in their homes, but our best schools are now giving courses in cooking so that all may become experts at it. It is well for even boys to know the simpler forms of cooking. In fact, the Boy Scout organization considers a knowledge of cooking so important that it requires its members to be able to cook in an appetizing way a number of simple dishes.

Poor cooking wastes food, endangers health, and

makes what we eat less palatable. Good cooking is so important that large hotels often pay their chief cooks larger salaries than are received by bank clerks, doctors or lawyers.

Why we cook our food.—There are five important reasons why we cook most of our food:

1. Cooking softens the food and breaks up its tissues so that they are more easily chewed and digested. Meats, most vegetables, and the harder fruits, especially, require cooking. Nearly all cereal grains are also cooked before being eaten.
2. Cooking causes certain chemical changes in some foods, making them easier to digest. For example, cooking green apples or other unripe fruits changes the starch into sugar. If fruit is eaten green the stomach must do the work of changing the extra starch into sugar. Not infrequently this proves more than the stomach is able to do, and indigestion follows.
3. Most foods have a better flavor, and are more palatable when they are cooked. For example, most of us would not care to eat raw flour, or uncooked meats, potatoes, or other vegetables. We not only want our foods cooked, but want them cooked in the particular way that we happen to like best.

4. Cooking kills many injurious germs found in certain foods. Most germs are killed by boiling, and all by oven heat sufficient for baking bread or meats. We learned in Book One, that it is sometimes necessary to boil even milk and water, in order to kill the germs of typhoid fever or other disease sometimes found in them.

5. Cooking our food and serving it warm has the advantage of bringing it up to the temperature of the digestive organs. The stomach works better when it is not cooled too greatly by cold foods.

How we shall cook our foods.—There is no one way to cook most foods which should take the place of all other ways. For example, potatoes can be cooked in at least a score of different ways. We have many recipes for cooking meats. Flour, and other forms of cereals, may be baked in the form of bread, rolls, cakes, or cookies, or prepared in many other ways.

Yet there are some methods of cooking which in general are better than other methods. For example, broiling is usually better than frying any food. Broiling softens and breaks up the tissues of meats or vegetables, while frying has the tendency to harden the tissues and make them more difficult both to chew and digest. Baking is a satisfactory way of cooking many kinds of foods.

Some of our foods, as the cereal breakfast foods, are sometimes not cooked long enough. Oatmeal, cream of wheat and other such cereals should be cooked for not less than half an hour, and are better still if kept simmering for an hour or more before serving.

Boy Scouts are expected to know how to cook

Yet such cereals are often served with only a few minutes of cooking.

Ready cooked foods.—Many different kinds of food now come to us already cooked. One can buy almost every kind of cereal ready cooked and put up in packages. Such prepared foods are scientifically

cooked at the factory before being put in the package, and come to us ready to serve. We can even buy canned meats, fruits, vegetables, and soups ready cooked and only requiring to be warmed before being served. The baker also offers us a tempting array of bread, cakes, cookies, and pies. Most of the ready-to-serve food now sold in the best markets is well cooked. Nevertheless, the greater part of our food should be cooked in the home. And girls, especially, should make it one of their chief ambitions to become good cooks.

Foods which do not require cooking.—While we require most of our foods to be cooked, it is nevertheless necessary that we have some food that is uncooked. This is because there are certain parts or substances in foods called *vitamins*, some of which are destroyed by cooking.

These vitamins are not well understood, but are known to be necessary to our health. It has been found that soldiers, sailors, or others obliged to live for some time upon canned or cooked foods, are affected with *scurvy* and other similar diseases. When they are given a diet including fresh fruits and vegetables containing vitamins the diseases disappear.

Our diet should therefore always contain such foods as lettuce, tomatoes, celery, fruits, nuts, and a reasonable proportion of milk. For these may be eaten raw, and the vitamins secured which are necessary to health.

Interesting things to do.—1. Make a list of the different foods which you eat, both raw and cooked. Another list of those you eat only when cooked. A third list of those you eat only raw.

2. Write down all the different ways you know of cooking potatoes; apples; meat; eggs; flour; corn meal or oat meal.

3. Make a list of the different dishes that you can cook. Are there others that you should learn to cook? Are you improving in your cooking?

4. Do you know certain housekeepers whose bread, pies, cakes and other cooking always turn out just right? Do you know other housekeepers whose cooking is not so successful? Do you think it worth while to learn to be the very best cook possible?

Questions to answer.—Give the case of the three men in the restaurant who wanted their food cooked differently. Why is the cooking of food so important? Give five important reasons why we cook our food. Explain why broiling is a better method of cooking meats than frying. What caution is given about the cooking of breakfast cereals? What is said about ready cooked foods to be found in the market? Why should we eat some uncooked foods? Mention several foods that may be eaten either cooked or raw. Certain foods that are eaten always raw. Still other foods that are always cooked before they are eaten.

CHAPTER XXI

WATER AS FOOD

Did you ever stop to think that when we buy certain foods we really purchase more *water* than real food substances!

For example, let us refer again to the table on page 139, which shows the proportion of water in different foods. Then if we will do a simple problem in arithmetic, we discover the following astounding facts:

> When we buy a gallon of milk, nearly three and a half of the four quarts we receive are water.
>
> When we purchase a bushel of potatoes, three of the four pecks are nothing but water.
>
> When we order a quart of oysters the dealer gives us considerably more than one and a half pints of water.
>
> When we bring home a dozen eggs, it takes nine to make up the amount of water in the twelve.
>
> Even a rich, savory piece of beef-steak is half water; and the meat of a chicken almost three-fourths water.

Water needed for our own tissues.—Yet we need not be surprised that our food contains so much

water. For we have already learned that our own tissues have in them a large proportion of water.

The organs which perform the most important work of our bodies, as the brain, the liver, and the kidneys are by weight three-fourths water; the muscles are about the same proportion. The blood and the lymph are about nine-tenths water. Even the bones have a large amount of water in them. Taken altogether, there is sufficient water in our tissues to make up over two-thirds of our entire bodily weight.

Uses of water in the body.—Our foods must contain a large proportion of water, therefore, because of the fact that the tissues of our bodies require so much water and because the body can not do its work without an abundance of water.

For example, our joints must have water. Every joint where two bones work together is enclosed in a sack or bag. This sack is filled with a liquid which is chiefly water. Without this liquid the ends of the bones would work on each other like the bearings of a machine without oil. A farmer whom I know ran the tine of a pitchfork into his knee in such a way as to destroy the bag holding the "joint water." His knee has grown very stiff and he has almost lost the use of the joint.

Organs that require water.—Water serves to protect and act as a lubricant for several important organs. The heart is surrounded by a loose sack

called the *pericardium*, which contains a little watery liquid. The lungs are enveloped in a similar bag, called the *pleura*, which is kept moist by a water-like fluid. The brain is enclosed in a water-tight casing and is surrounded entirely by liquid.

The skin, as we have already learned, regulates the heat of the body by the evaporation of water through the pores. As much as several quarts of water a day may be used in this way.

Water necessary to the life of cells.—Not only do the organs require water for their work, but every single cell of the body requires water to continue its life; in fact, it is bathed on all sides by lymph, which is chiefly water. So necessary is water to the life of cells that, should the water be in some way dried out of our cells and tissues, they would immediately die.

These facts help us to understand why one can live longer without nourishing foods than without water. For when we are obliged to go for a time without food, the body can use up the surplus of fat and other food substances which have been stored away in the tissues. But water can not be stored up for future use; therefore we can live but a short time without it.

No wonder, then, that thirst is so dreadful a thing when men are lost in a desert or adrift on the ocean, where no drinking water is to be had. For thirst is the protest of every organ, tissue and cell of the body against the injury that comes from lack of water!

Water obtained from foods.—A large part of the water we need comes directly from our foods, most of which, as we have seen, have much water in them. To the drier foods, such as the cereals, we add water in

Still another use for water. Besides being so necessary with our food, water provides opportunity for clean sport and fun. Every boy and girl should learn to be at home in the water

cooking. For example, each pound of rice as bought at the store comes to the table with about three pounds of water added.

We also add water to vegetables and meat when we serve them in soup or with gravies. Fruits are cooked in water or else syrups, consisting largely of water,

are used. When we drink milk, cocoa, tea or coffee we are, of course, drinking chiefly water.

Drinking plenty of water.—But no matter how much water we get in our foods we also need to drink water by itself. It might seem that thirst would be a good guide to our need of drinking water, yet we often would be better for a glass of water even when we do not feel thirsty. There is, in fact, no danger of our drinking too much pure water. These are good habits to form about drinking:

1. We should make it a firm rule not to drink freely of very cold water when we are much heated.

2. We should never drink water in large quantities just before violent exercise, as in a game. Athletic coaches do not allow their men to drink water during a contest.

3. It is well to drink a glass of water on rising in the morning and on retiring at night, even if we do not feel very thirsty. Water may be drunk at meal time, but never to wash down food that has not been properly chewed. Drink a glass or two between meals.

4. Both because of health and for the sake of good manners we should drink slowly, and not gulp a glass of water down in a few swallows.

Water from wells.—Most of the water we drink is either pumped from near-by wells, or drawn from the faucet of a city water system.

Shallow wells, such as most of those on farms and in villages, often contain impurities carried in by surface drainage. An examination of many farm wells made under the direction of experts showed more than half of them to contain disease germs dangerous to health.

Epidemics of typhoid fever, cholera and other diseases have frequently been traced to water from wells polluted by drainage from some source of infection. Water from shallow wells should always be looked upon with suspicion, especially if near barns, outhouses, cesspools or other sources of filth.

The city water supply.—Towns and cities draw their water supply from various sources. Chicago pumps its water from intakes several miles out in Lake Michigan; New York from reservoirs fed by mountain streams; St. Louis from the Mississippi River. Many smaller places pump their water from deep wells.

The water from any of these sources is pure enough providing it has not received drainage from some source of infection. The trouble is that most towns and cities pour their sewerage through pipes into the rivers or lakes near at hand. Disease germs from this sewerage sometimes find their way into the intake

pipes of the city water supply and make the water unsafe for drinking.

To protect against polluted water, many cities filter their water supply through great beds of gravel and sand. This removes most of the germs and so purifies the water.

Two lessons from other nations.—We may learn a valuable lesson concerning our water supply from the ancient city of Rome. There are still standing sections of a great aqueduct built more than eighteen centuries ago to bring pure water from distant hills to the great city. The Romans did not know that disease comes from microbes, or even that microbes exist, but they allowed no impurity to enter their supply of drinking water. That is a good rule for us to-day.

The other lesson comes from China. Many of the large cities of China take their drinking water directly from rivers into which all manner of filth and impurity are constantly pouring. Microbes swarm by the million in every drop of water used by thousands of people. Yet very few take disease from the impure water for the simple reason that it is a national habit to *boil the water before drinking it.* The Chinese usually steep tea in the boiling water, but the main point is that they *kill the disease germs* by boiling the water.

Two good rules.—1. Following the example of the ancient Romans, each town and city should

use every care to keep its water supply clean and pure. Every person who owns a well should do his best to see that it does not receive drainage from surface water nor filth from any source.

2. Following the example of the Chinese, every one who has to drink water which is not known to be free from disease germs should boil it before drinking it. The following of these two simple rules would do much to save needless sickness and death.

Interesting things to do.—1. Make an investigation to discover where your drinking water comes from. If you live where there is a city water supply learn what is the source of supply—wells, springs, streams or lakes.

2. Inquire of your father, or some one else who can tell you, the difference between a *driven* well, a *bored* well, and a *dug* well. If you use water from a well, learn to which class your well belongs. Which is best?

3. Investigate wells near at hand, and note whether any of them are open around the top so that insects, mice or other small animals can get in.

4. Remember that wells receive their supply of water from underground streams or from water that has soaked down from the surface. The underground slopes are not always in the same direction as those on the surface. Do you know

of wells that are near enough to barnyards, cess-pools or other dirty places that drainage from these sources probably enters the wells?

Questions to answer.—What is said about the amount of water we purchase in certain foods? Why do we need so much water in our foods? What proportion of our own bodies consists of water? Explain some of the different uses of water in the body. Mention certain of the drier foods to which we add water in preparing them for the table. Give rules that we should follow in drinking water. Where does most of our drinking water come from? What dangers of disease may drinking water bring us? Name some of the sources of city water supply. What two lessons about drinking water are taught us by ancient nations?

Health Problems

1. Why does a potato kept over winter shrivel up and grow soft? Do you suppose cells in the tissues of our bodies suffer in somewhat the same way when they lack sufficient water?
2. Suppose a city has a poor water supply and also poor paving on its streets, but can afford to improve but one of the two, which would it better improve first? Why?
3. Explain different ways in which cities filter their water supply.
4. If you live in the country study carefully the surroundings of your well. If it is a dug well, ask your father if any impure drainage could reach it.

CHAPTER XXII

WHERE DIGESTION TAKES PLACE

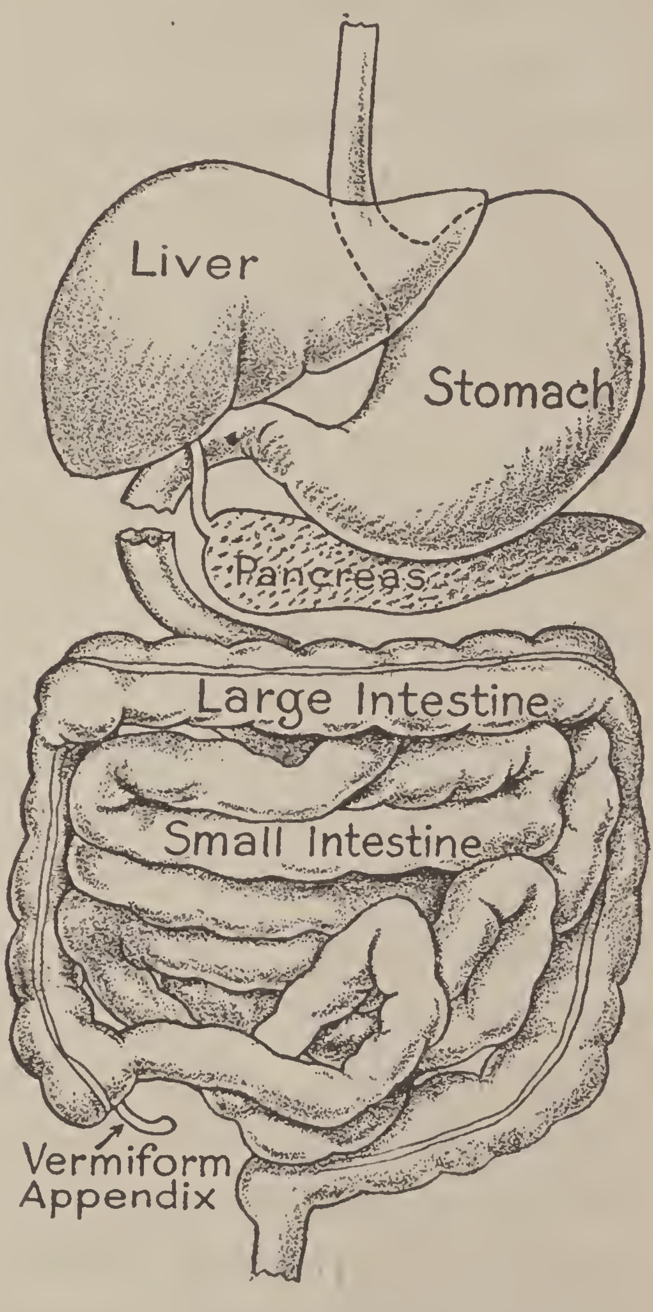
When our food is once cooked and eaten, we usually think no more about it. Yet when we have chewed and swallowed the meat, bread, or egg, it is very far from being ready for the body to use. It must still go through the process called digestion. Before the food is ready for the blood to carry to the tissues, it must be dissolved, or made over into liquid form. While the process of dissolving is going on, certain chemical changes are also taking place. This dissolving and changing of the food to prepare it for the use of the tissues is what we mean by digestion.

Where digestion takes place.—Digestion really begins in the mouth. Here the food is chewed and mixed with the saliva, which partly dissolves and starts the process of digestion of the starch parts of the foods.

The digestive tube begins at the back of the mouth, passes down through the throat and chest, and finally winds back and forth across the lower part of the body, called the *abdomen*.

Throughout most of its length, the digestive tube

is very narrow, being only one or two inches in diameter. It is long enough, so that if stretched out straight, it would reach a distance of about twenty-five feet.



The digestive tract

Different parts of the digestive tube are called by their own particular names. At the back part of the mouth comes the *throat*, and immediately below this the *gullet*, which is also called by the hard name, *esophagus*. The gullet opens into the *stomach* and the stomach in turn opens into the *intestine* or bowel. It is the part called the intestine which lies in folds across the abdomen.

The intestine consists of two parts, first called the *small intestine*, which comes next after the stomach; the small intestine leads into the *large intestine*. The small intestine is much longer and narrower than the large.

The work of the stomach.—The stomach is an enlarged part of the digestive tube. It is shaped something like a pear, and is several inches in diameter. Its walls, like those of the remainder of the digestive tube, are of muscle, and therefore contract and expand to accommodate the amount of food in the stomach.

One of the chief uses of the stomach is to serve as a kind of storage place, or bin, for the food. In the time that it takes us to eat a meal, enough food is put into the stomach to keep the digestive machinery busy for several hours. The stomach expands as the food is swallowed into it, having a capacity of several pints when very full.

Once the food has reached the stomach, it finds the stomach acting as a kind of churn. The walls contract now at this place and now at that, squeezing and pushing the food about until it is thoroughly mixed with a digestive fluid, called *gastric juice*, which the stomach wall gives out.

Still another important work of the stomach is to kill the bacteria which may be taken in with the food. Whenever we eat we are constantly swallowing any number of bacteria, most of which are harmless. It often happens, however, that living disease germs are taken in with the rest. Most of these are killed by the acid of the gastric juice, and therefore do us no harm.

The gastric juice, besides helping dissolve the food, brings about certain chemical changes in the proteid,

making a portion of it ready for the blood. When the food has been sufficiently churned about, dissolved, and changed by the gastric juice, it is ready for the intestine. A small muscular gateway, called the *pylorus*, which stands guard between the stomach and the small intestine, then opens and allows the liquid food to pass on.

Digestion in the intestine.—The liquid food from the stomach finds its way slowly along the folds of the small intestine. While in the intestine it is mixed with still other digestive fluids, which continue the process of dissolving and changing it to make it ready for the use of the body. While it is in this stage the food, now a thin liquid, is known as *chyle*.

Besides the digestive juices which are supplied by the stomach and intestine, two other important fluids aid in the digestion of food. These are the *bile*, which comes from the liver, and the *pancreatic juice*, the most important digestive fluid of all, which comes from a small organ called the *pancreas*.

From the intestine into the blood.—How the food manages to pass from the intestine to the blood-vessels is not easy at first to see. But once we remember that certain liquids can easily pass through living tissue, as we found in our experiment with the salt water, the mystery becomes clear.

The digestive tube is lined throughout its entire length with *mucous membrane*. This is a sort of skin,

but very much softer, thinner, and more delicate than the covering of the body. Mucous membrane has the power of absorbing water and any substances that may be dissolved in it.

While the digestion of the liquid food begins in the mouth, the most is absorbed, however, from the chyle of the intestine. The delicate lining membrane of the intestine projects in many folds and these are covered by thousands of little rootlets called *villi* which are rich in blood and lymph capillaries. Each separate villus is busily at work drinking in the liquid food which is now ready for the blood. The villi finally pour into the blood and lymph circulations the precious material they have absorbed.

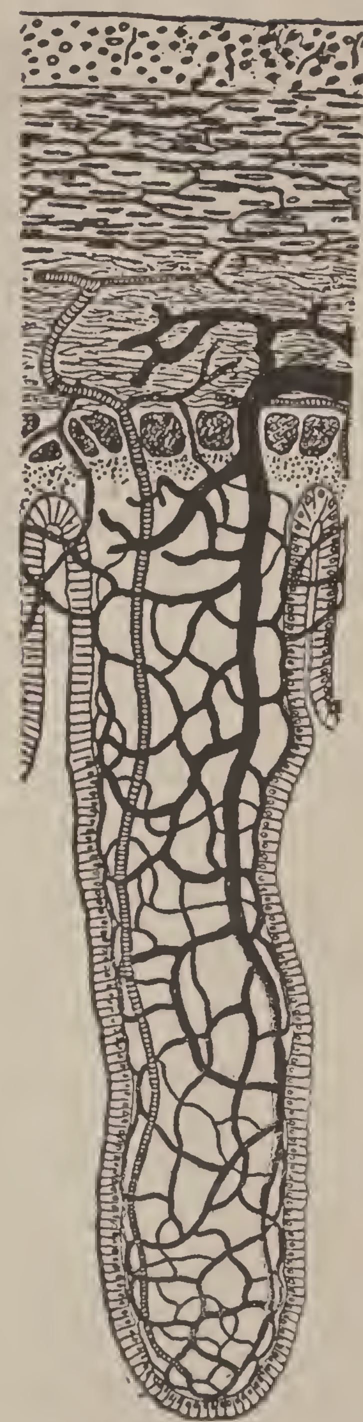
The villi as they appear on the lining of the intestine

Things that hinder digestion.—We have already learned that whatever portion of the body is working hardest, demands an extra supply of blood. Immediately after we have eaten a meal and while the process of digestion is at its height, a large amount of blood is needed by the organs of digestion.

It is easy to see that if we play or work hard immediately after eating, the blood will be required for the muscles. If we begin to study hard, the blood will be required by the brain. In either case it is drawn away

from the stomach and intestines, and they are robbed of their proper share. Digestion is then hindered and the health suffers.

Nervousness, fear, excitement, or any other strong feeling, also hinder the work of the digestion. Exciting games or plays carried on immediately after a meal are therefore unwise, and should be postponed until digestion is well under way.



A villus of the small intestine greatly enlarged

Problems to investigate.—

1. Sometimes when you have eaten too much, has your stomach felt full and stuffed, and perhaps pained you? This was the stomach's way of telling you that you had given it too much work to do, and that it was having a hard time of it.
2. Point out on the picture on page 165 all the different parts of the digestive tube, and tell what work goes on in each part. Especially note the appendix, which is at the point where the small intestine joins on to the large. It is inflammation of the appendix

that causes appendicitis, to cure which the surgeon removes the appendix.

Facts to remember.—1. No matter how much food we may eat, it must be *digested* before the body can make use of it. The digestion of just the right amount of suitable food brings a comfortable, pleasant feeling. For example, it is proverbial that one feels good-natured after a satisfactory meal. If we feel distress after eating we may be sure that something is wrong with our digestion.

2. Digestion begins in the mouth and continues in the stomach and the small intestine. The fluids or juices that help in digestion are the *saliva* of the mouth, the *gastric juice* of the stomach, certain fluids of the intestine, *bile* from the liver, and especially the *pancreatic juice* from the pancreas.

3 By far the most, if not all, of the digested food is absorbed by the *villi* of the small intestine. The digested proteid and carbohydrates are picked up by the blood capillaries and carried first to the liver, and the digested fat by the lymph capillaries, and carried to the blood.

Questions to answer.—After the food is chewed and swallowed, what must yet be done to it before it is ready for the body's use? What is meant by *digest-*

ing the food? Where does the digestion of food take place? Name the different parts of the digestive tube. Describe the stomach. Explain how the stomach is a storage place for food. Describe how the stomach acts in churning the food about during digestion. What important work does the stomach do in reference to disease germs? What digestive fluid is supplied by the mouth? By the stomach? By the liver? By the pancreas? What are the *villi?* What is the work of the villi? After the villi have absorbed the food where do they carry it? Name several things that will hinder digestion. What are several of the most important points to be remembered from this lesson?

Health Problems

1. Imagine you wish to explain to some one who has not read about it just how the food we eat becomes living tissue. How would you tell the story?
2. John noticed that after he had eaten pork chops for his dinner in the evening he did not sleep well. What was the probable condition in his stomach?
3. The Blank family never seem very happy at meal time. Sometimes the children are cross about their food and sometimes father or mother scolds. There is hardly a meal some one does not shed tears. What effect has this state of affairs on digestion?
4. How can the children of a family make it easier for their mothers to plan and prepare the meals?

CHAPTER XXIII

THE WORK OF THE TEETH

The first thing one naturally thinks of concerning his teeth is whether they look white and clean, and whether they ache or not. There are other questions, however, to consider. The teeth have three chief uses, all of which are important. These are:

(1) To grind the food, thus making it ready for the stomach.

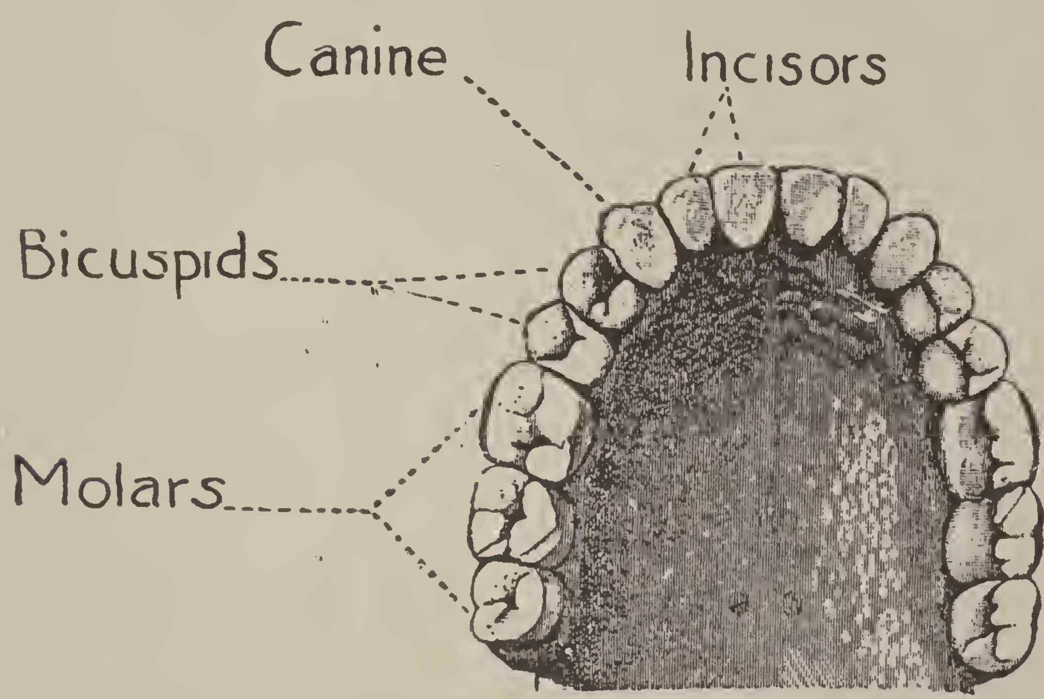
(2) To aid in making the sounds in speech.

(3) To add to the attractiveness of the face.

The work of the teeth in grinding the food.—Perhaps the principal use for which nature intended the teeth is to help make the food ready for the stomach. Certain it is, anyway, that the animals whose stomachs are not able to handle their food in large coarse masses have teeth for tearing or grinding it.

Likewise, each kind of animal has teeth of the form best adapted to preparing its particular sort of food. Dogs, wolves, and other flesh-eating animals have sharp, strong teeth for tearing and rending their prey. Cows, horses and many other grass-eating animals have broad, flat teeth for grinding their food into a pulp.

Since man eats many different kinds of food, he has teeth of several different shapes. The four incisors at the front with their sharp edges, are just right for biting through a crust of bread, a piece of meat or any other substance that needs cutting. The canine and the bicuspids at the corner of the jaw, are adapted to



The permanent teeth as they appear in the upper jaw

tearing or holding. The molars, farther back in the mouth, with their broad, flat surfaces are fitted for grinding the food into small bits. Note all of these in the above picture, and learn their names and locations.

Making sure of good mastication.—Mastication, or chewing the food, is one of the most important acts of digestion. If anything is wrong with the teeth so that the food can not be properly ground up into fine

bits before being swallowed, digestion is hindered, and some kinds of food are never properly digested.

One somewhat common defect that interferes with proper mastication is the failure of the teeth of the upper and the lower jaws to fit together right when the jaws are closed. This is called faulty *occlusion* of the teeth, and is sometimes indirectly due to adenoids. A more frequent trouble, however, is that from decayed teeth, which finally ache and so hinder chewing, or else come out and leave a vacant space, which prevents proper grinding.

Many persons who have good teeth, however, do not properly masticate their food. Sometimes this is because they eat in a hurry, and do not take time to chew each mouthful. In other cases it is simply a matter of habit, or of greedy eating; they have become accustomed to bolting their food in coarse chunks, and so this is their manner of eating.

Boys and girls by the age of twelve or thirteen years should have firmly formed the habit of eating slowly, quietly and daintily, thoroughly masticating their food before swallowing it. There are few ways in which good breeding shows more readily than in our manner of eating.

How the teeth help in speech.—One of the best ways to understand the part played by the teeth in the forming of certain sounds in speaking is to notice some one trying to talk who has lost some of his front teeth.

There are some sounds, such as soft *c*, *ch*, *th*, and *v*, which can not be correctly spoken without the aid of the teeth.

Very crooked teeth also may interfere with correct speech by making it impossible to produce certain sounds. Those who are obliged to wear false teeth often find that these are enough different from their own teeth that they have much trouble in learning to speak naturally with a strange set of teeth in the mouth. If we would have clear, distinct, beautiful speech, we must have good teeth.

The teeth and good appearance.—One who has a set of clean, white, even, sound teeth is pretty sure to have an attractive face; for there is no other feature that has more to do with good appearance than the teeth. And it often happens that good looks of what might be a pleasing face are spoiled by dirty, crooked or decayed teeth.

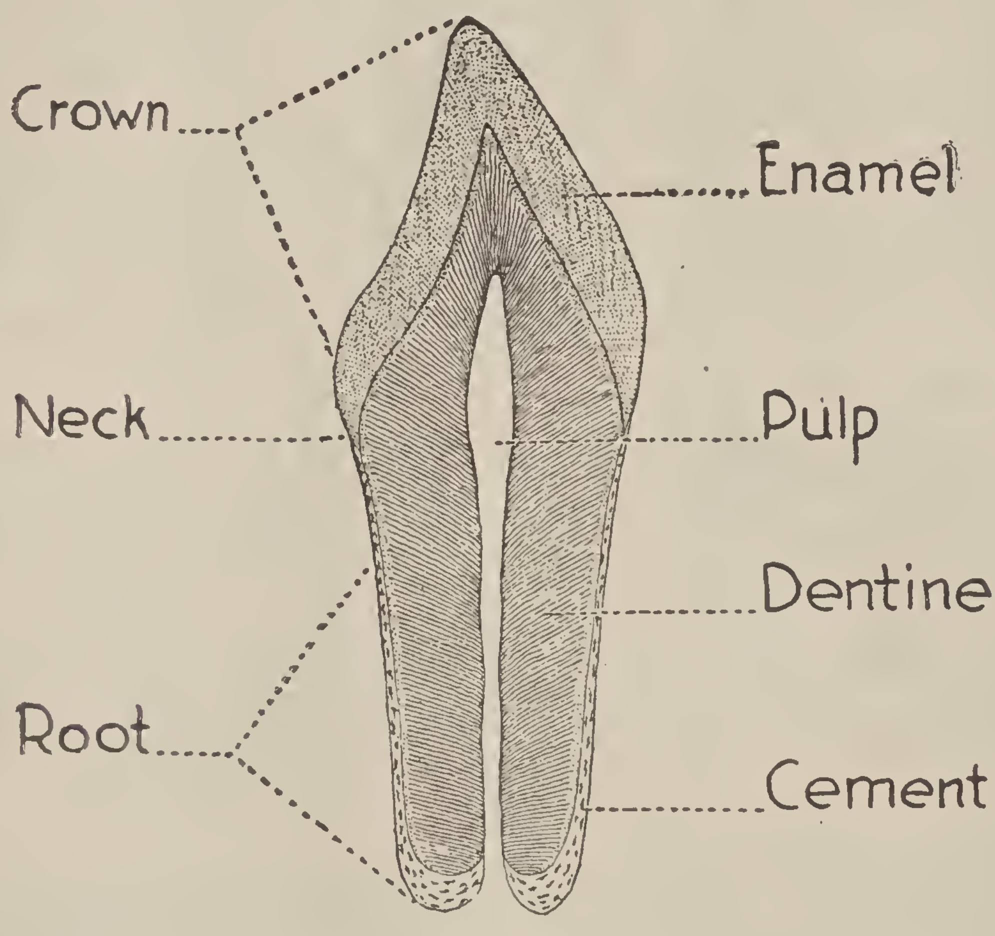
The boys and girls who study this book should have good teeth. Their teeth should not bear stains, nor be discolored, but should be clean and ivory white. Their teeth should not be decayed, but if cavities have appeared they should be filled by a good dentist. Their teeth should seldom ache, if properly cared for.

The structure of a tooth.—A tooth consists of three parts; these are:

(1) The crown, or the part which can be seen above the gum.

(2) The neck, which is a slight narrowing of the tooth just at the edge of the gum.

(3) The root or roots, which fit firmly into holes in the jaw bone.



A section of the tooth as it would appear if split lengthwise

At the very center of the tooth is a *pulp* cavity. This is a chamber containing blood-vessels and nerves, which enter the tooth by a small opening at the tip of each root.

Immediately surrounding the pulp is a substance called *dentine*. This dentine, which is a hard structure, makes up the greater part of the bulk of the tooth.

In the root part of the tooth the dentine is covered with *cement*, which is hard and bone-like. In the crown, or that part of the tooth which can be seen above the gum, the dentine is covered by a thin coat of enamel. This is the hardest substance in the body, and it serves as an excellent protection to the dentine and to the sensitive pulp of the inner tooth. The enamel is the glistening white part of the teeth which we see, and which we should daily brush.

Why teeth decay.—Clean teeth seldom decay. This is because decay is usually caused by the action of bacteria which thrive on food particles left in the mouth. The work of the bacteria causes the enamel to soften and give away. When the dentine is reached the decay is much more rapid, and the protecting shell around the sensitive pulp becomes so thin that sudden heat or cold in the mouth, or biting on a hard substance causes severe pain.

In time the dentine may crumble away until the pulp with its tender nerve roots is inflamed. Then the tooth becomes very sore and aches continuously. A tooth which has reached this stage usually has to be pulled, or else a new crown of some hard substance put on the root which remains.

The action of bacteria upon the enamel is made easier by the formation on the teeth of a hard substance deposited by the mouth secretions called *tartar*. The deposit of tartar is to be found chiefly between the

lower teeth, and around the base of the teeth at the edge of the gum. The white crust of tartar can usually be seen on teeth that have not been cleaned by a dentist for some time. Even if our teeth do not ache, we should have a dentist examine and clean them twice a year.

Reasons for keeping our teeth sound.—It will be worth while at this point to recall a lesson we learned in Book One: just as clean teeth can only with difficulty decay, so also sound teeth do not ache. So if we would escape toothache, we must keep our teeth sound. Once let a tooth develop a cavity which causes it to ache, and there is pain ahead; for the best of dentists can not clean and fill such a cavity without causing it to pain us. And if we allow it to run on until the tooth must come out, the hurt is worse yet; so just to escape unnecessary pain and suffering it pays to look after our teeth.

But there is an even more important reason why we should keep our teeth sound. Decaying teeth give out a poison that affects the health of the entire body. School physicians have found that many children who do not learn easily at school and who are unable to keep up with their classes are as bright as anybody and get their lessons easily when once their decaying teeth have been remedied. The poisons from decayed tooth cavities affect the brain and nerves so that they can not do their full work.

A third reason for keeping our teeth sound is that it is more or less of a disgrace to allow our teeth to decay. Decaying teeth mean rotting food particles, unclean mouths, and a poisoned breath. Such teeth tell every one who sees them that we lack the pride and habits of cleanliness which would prompt us to keep our teeth so clean that they would not decay.

Pyorrhea.—There is another disease of the teeth, known as pyorrhea, which is an even more important cause of bad health of the whole body than is the decay we have just described.

Pyorrhea is the inflammation at the edges of the gum and the formation of little pockets of pus between the gum and the tooth. These pockets burrow their way down along the teeth even to the very tip of their roots. As a result the soft gum shrinks away from the tooth, and its bony socket is dissolved. Hence the tooth appears to grow longer and longer. More and more of the tooth is exposed and it becomes looser and looser till it may even drop out or must be pulled. The pus around these teeth has a very bad odor, and makes the breath very offensive. This pus mixes with the food which is chewed and so is swallowed. The stomach is thereby poisoned; dyspepsia results. More of the pus is absorbed from the gum directly into the blood and poisons other organs, especially the joints and the kidneys.

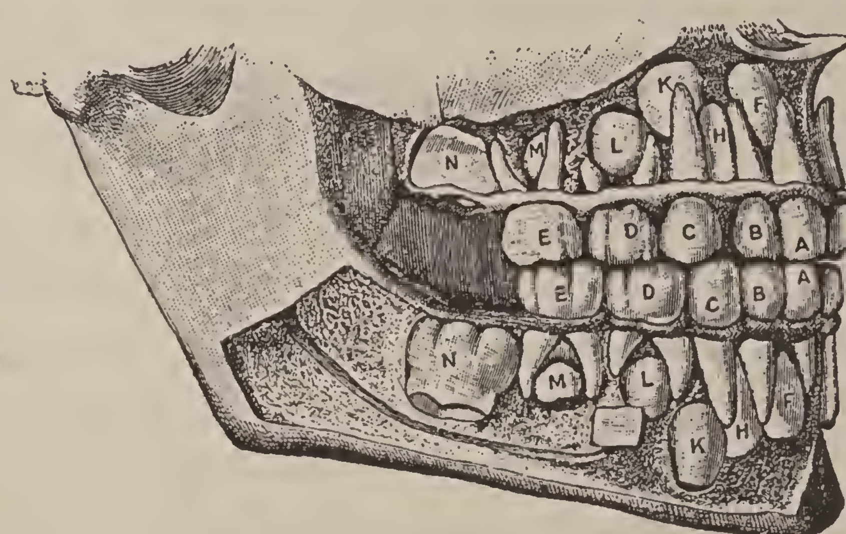
Pyorrhea is most likely to develop in the mouths of those who habitually neglect their teeth, of those who brush them unwisely, only scraping their tooth-brushes across the teeth at their gum margins; and of those also who have diseased noses and throats.

How to preserve our teeth.—By following a few simple rules nearly every one could keep his teeth sound and sweet from childhood to old age. These are the rules:

1. Brush the teeth thoroughly twice each day, using a good tooth paste or powder once a day to remove the tartar. If they are brushed but once a day, this would better be at night.
2. Run a thread between the edges of the teeth each night. A spool of dental floss for this purpose can be bought for a few cents and will last for many months.
3. Eat an abundance of gritty and fibrous foods, chewing them well, so that the teeth may be given sufficient exercise.
4. Do not crack nuts with the teeth or bite upon very hard substances; for this will chip the enamel and so expose the dentine to rapid decay.
5. Do not change suddenly from very hot to very cold substances (or the opposite) in the mouth; for this may crack the enamel much as a glass is broken by too sudden an application of heat or cold.

6. Do not wait for an aching tooth to drive you to the dentist. An ounce of prevention is worth a pound of cure. Pay the dentist for keeping your teeth sound instead of for patching them up after they have decayed. This will cause you less pain and cost you less money.

When and how our teeth appear.—Because it is so important that we should understand about our teeth, we will review a few points which we learned in Book One.



This picture shows the temporary or milk teeth on the right side, and the permanent teeth forming in the jaw ready to take their place. Temporary Teeth: A and B, *incisors;* C, *canines;* D and E, *bicuspids.* Permanent Teeth: F and H, *incisors;* K, *canines;* L and M, *bicuspids;* N, first (sixth-year) molars. The later molars are not shown.

A full set of teeth numbers thirty-two, sixteen in the upper jaw and sixteen in the lower jaw. But the child has but twenty. The first eight of these—the four front teeth of each jaw—come in during the first year. At two years of age the child should have twenty teeth. These twenty, called the milk teeth, are shed between the ages of seven and ten.

The first permanent teeth, the four sixth-year molars, should appear during the sixth year. As the twenty

milk teeth come out they are followed by permanent teeth which take their place. At the age of ten or eleven one should therefore have twenty-four of his permanent teeth. Four additional molars have come in by the age of twelve or thirteen. It is probable therefore that the boys and girls who study this book will have from twenty-four to twenty-eight teeth. You will probably have to wait until you are between seventeen and twenty-one years (or possibly even older) before the last four molars, or "wisdom teeth," appear, thus giving you your complete count of thirty-two.

Interesting things to do.—1. By looking in a mirror, carefully count your teeth. Have you the proper number for your age?

2. Make a drawing of a tooth to show its three parts, crown, neck and root. Note that some teeth have but one root, while others have two or three.
3. Make a drawing of a tooth split from crown to root showing (1) the pulp, (2) the dentine, (3) the enamel.
4. If possible, secure from a dentist a number of teeth, both sound and decayed, and examine the different parts of their structure.
5. Demonstrate how to brush the teeth properly, moving the brush up and down and not across the teeth. Also demonstrate how to clean between the teeth with a piece of thread.

6. Examine your teeth for tartar; for cavities; for deposits of food or for discolored spots. Who in the class has the best teeth? The best kept teeth? Let the class report on when each paid the last visit to the dentist.
7. By pointing to your own teeth or those of a classmate, name each different tooth, telling about when it appeared.
8. Demonstrate the use of the teeth in forming certain sounds in speech.

Questions to answer.—What are three principal uses of the teeth? Explain how the teeth of different animals are adapted to the kind of food they eat. What four different names are used to classify our teeth? What different reasons account for poor mastication of food? Explain to just what part of the tooth each of these terms applies: crown, neck, root. Describe each of the three different layers which go to make up the crown of a tooth. Tell what causes teeth to decay. What are three important reasons for keeping our teeth sound? Give the rules for preserving the teeth. Explain the order in which our teeth appear, giving the approximate age at which the different teeth come in.

Health Problems

1. James brushes teeth pretty well, but does not wash out his tooth-brush very well. Give directions for James.
2. Teeth ofttimes become ulcerated far down on the root and require X-ray photographs to reveal the ulceration. How might such a condition cause bad health?

CHAPTER XXIV

GLANDS AND THEIR WORK

When you have been sick you may have noticed the doctor pressing gently over your body just underneath the ribs on the right side, or even thumping there a little with his finger and listening to the sound made. He was examining your liver to see whether it was swollen or not.

In fact, you can feel the lower edge of your liver yourself by pressing your fingers up just under the edge of the ribs on your right side. Perhaps the best idea of the liver which we can get, however, is to study a pig's liver as it comes from the butcher shop ready to be cooked for your meal. The liver is the largest gland of the body and weighs several pounds. But let us first inquire what we mean by *glands.*

Gland laboratories.—Glands are the body's special factories or laboratories, whose business it is to manufacture certain substances required for carrying on some particular work.

Each gland supplies its special kind of fluid or juice, which it gives out to do whatever work is required of it. There are many different glands in the body, some of them large and some small.

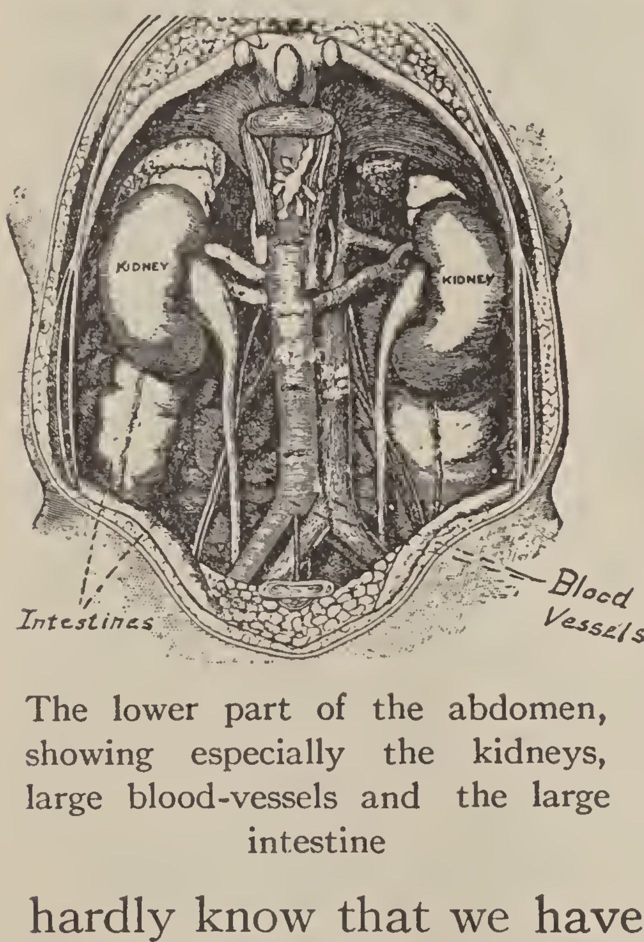
The liver.—The liver is not only the largest, but one of the most important glands of the body. It is filled with millions of blood capillaries and is always crowded full of blood. If you will observe a piece of liver while it is being cut, you will notice that the blood constantly oozes from it as it does from a piece of beef-steak. The liver needs all this blood because of the important work it has to do, and also because one of its most important duties is to purify the blood.

The first task of the liver is to act upon the food which is carried to it in the blood directly from the intestine. We learned in a preceding lesson how the villi gather up the liquid food from the intestine. This food when first absorbed from the intestine is not ready for the use of the body. It must first be worked over by the liver laboratories, before it can be used to build new tissue or supply bodily energy. The blood capillaries of the villi upon leaving the intestine unite into larger vessels, and finally deliver their load of liquid food to the liver. The liver proceeds to prepare the food for the use of the tissues.

So important is this work done by the liver upon the food brought to it from the intestine, that if the liver should refuse to do its work one would die.

Besides acting upon the food, the liver does another important work. The blood in the large vein which runs from the intestine to the liver contains also many impurities. While in the liver this venous blood

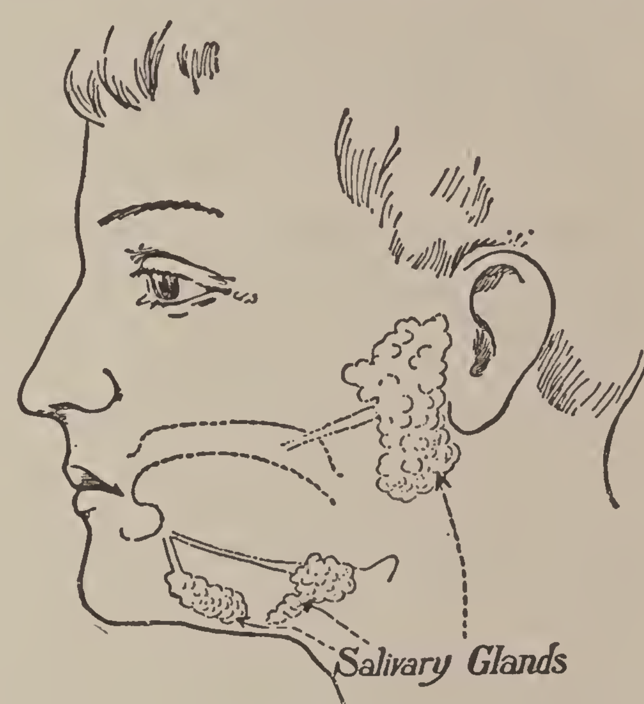
is worked over, and much of its waste material removed from it. The blood is in this way purified and again prepared for the use of the body. The liver is very economical in its work, and much of the waste material taken from the blood is not thrown away. It is made over by the liver into the *bile*, which, as we have already learned, is an important fluid used in the digestion of food in the intestine.



The lower part of the abdomen, showing especially the kidneys, large blood-vessels and the large intestine

Alcohol and the liver.—It is easy to understand from these facts that to be well and strong one must have a liver that is doing its work properly. Ordinarily with right food, exercise, and other good habits of living, our livers never trouble us and we would hardly know that we have one in our body. Probably the greatest enemy of the liver in the world to-day is alcohol. Alcohol attacks the liver and injures it in many ways so that it is no longer able to do its full work in making over the food, nor to remove the waste materials from the blood. The drunkard's liver is often found to be so diseased that it is little better than no liver at all, and that is, of course, serious.

The kidneys.—There are two kidneys, one located on each side just above the small of the back. The kidneys are bean shaped and are almost the size of the palm of the hand. They are very important glands. It is their work to remove waste materials from the blood. They get rid of the ashes of the food. This is so important that diseases of the kidneys which hinder them in their work are much to be dreaded. One kidney disease, called Bright's Disease, causes a great many deaths.



Salivary glands

Here again we find that alcohol is the greatest enemy of the body's glands and their work. Physicians tell us that drinkers, even of beer, are much more liable to kidney disease than abstainers.

The salivary glands.—The saliva which keeps the mouth moist and helps to dissolve the food, is supplied by three sets of glands on each side of the jaw. The saliva is very important in the digestion of starchy foods. The bad habit of spitting which some people have, is not only disgusting, but it wastes the saliva which is needed for digestion.

You may have noticed that when you are frightened or nervous or embarrassed, your mouth becomes dry. This is because fear or nervousness stops the work of the salivary glands. Since the gastric glands of the stomach are affected somewhat in the same way, it is easy to understand why digestion goes on better when one is in a happy state of mind and free from nervousness and fear.

The disease called *mumps* affects the salivary glands, causing them to swell and become very painful.

Other glands.—There are many other glands in the body besides those we have mentioned. The work of some of them is not yet understood. Certain glands do not have any ducts or tubes leading from them to carry the substance they manufacture to other organs. They do their work upon the blood as it passes through them. The *thymus* gland is such a gland as this. It is located just behind the breast bone; it is large in childhood and diminishes in size as one grows older.

The *thyroid* gland is located in the neck, just below the Adam's apple. The disease called goiter sometimes causes this gland to swell, and make the throat larger in front. Surgeons sometimes perform an operation to remove this trouble. The work of the thyroid gland is very necessary to life and health. If the gland is too active the patient becomes thin, very nervous, the pulse fast and the eyes prominent; if it is too little active, the person becomes fat and sluggish in nature.

Facts to remember.—1. The body has many special organs called *glands*. Each kind of gland has its own special work to perform. Just as one factory makes shoes, another cloth and a third soap, so one kind of gland manufactures saliva, another bile, another gastric juice, and so on.

2. The work of some of the glands is not yet well understood, but each gland has some work to perform which is necessary for the welfare of the body.

Interesting things to do.—1. Examine the liver of a pig or a chicken and find a small, greenish-looking bag filled with liquid attached to it. This bag contains surplus bile stored up for use as needed.

2. Notice the sudden flow of saliva in your mouth when appetizing food is placed before you. The saliva enters the sides of the mouth through small ducts leading from the glands. The flow may sometimes be so strong that a fine stream can be seen spurting from the duct.

3. Observe whether any of the persons you meet have swollen thyroid glands; that is, whether their throats are enlarged in front. Girls from twelve to sixteen years often have slight goiter swellings of such kind on their throats. These usually disappear without having anything done for them.

Questions to answer.—What is the work of the glands? Which is the largest of the glands? Where is your liver located? What important work is done upon the food by the liver? What does the liver do in purifying the blood? How does alcohol act upon the liver? Where are the kidneys found? What is the work done by the kidneys? How does alcohol affect the kidneys? Where are the salivary glands located? How many salivary glands are there? What fluid is supplied by the salivary glands? What disease sometimes affects the salivary glands? Where is the *thyroid* gland located? What disease sometimes attacks the thyroid gland?

Health Problems

1. Henry has mumps. What glands are affected?
2. Imagine you have a friend who does not know about the glands of the body. How would you tell him about them to make him understand?
3. Tears are manufactured by glands just over the eyes. What different causes will make tears flow? We wash our windows every few weeks. How frequently are the eyeballs washed?
4. Explain the difference between ductless glands and glands that have ducts.
5. Make a list of all the glands of the body which you can think of or learn about, giving the work of each.
6. Why does the throat often feel sore on the outside when we have tonsilitis?

CHAPTER XXV

THE WONDERFUL BODY

It seems strange to us now that many of the ancients used to look upon the body as vile and not worthy respect and care. We of the present day have come to see that our bodies are very wonderful creations. Not only is the body the most marvelous machine in the world, but it is beautiful as well.

When painters have wanted something beautiful as a subject for their pictures, many of them have chosen to paint the human body. When sculptors have sought an inspiring subject for their genius to work upon they have chiseled in fine marble the human form. So we have in our art galleries and museums many pictures and sculptures which show the grace and beauty of the body.

Our bodies become still more important when we stop to think what they mean to us. We all want good minds, but our powers of mind can be no better than our brains. We all want skill and endurance, but skill and endurance can never excel the strength of muscles and nerves. We all want to be well and live long, but health and length of life are determined by

the well-being of our bodies. We all want to make a good appearance and have people think well of us, but our character is judged largely by our bodily carriage, poise and self-control.

The parts of the body.—We have in our various lessons studied the different organs and parts of the

Ready for action. Starting pose for a sprint race

body, but we have not yet considered the body *as a whole*. Let us think in this lesson of all the organs and parts as being united and working together. Let us then stop to note how these parts are related to each other.

It is convenient to think of the body as made up of three main parts:

(1) The head.
(2) The limbs.
(3) The trunk.

The head.—The head governs all the rest of the body. It contains the brain, through which we do all our thinking and which governs our acts. In the head are located the most of our special senses. Here are the organs of sight, hearing, taste and smell.

Probably the most noticeable part of the head is the face. It is the face that gives us our "looks," or appearance. Underneath the skin of the face lie hundreds of delicate muscles and sensitive nerves. The nerves bear messages from the brain, and every changing thought causes some change in the muscles of the face. This produces our "expression"—our smiles and frowns, or our look of glum nature or good cheer.

The limbs.—By the limbs we mean the arms and the legs. It is the possession of these limbs, with the work they can do, which allows man to occupy his exalted position on this earth. The shape of his legs makes it natural for him to stand upright, and this the baby does just as soon as he is strong enough without any teaching. It is the hand, however, which is the wonderful instrument that distinguishes man from all animals. It is the hand which makes it possible for man to rule the world, to erect our buildings, construct or use our machines, write our books, or do any one of the many things which men can do better

than animals. No doubt man has risen above the animals quite as much because of his hand as his brain.

The trunk.—The trunk consists of a cavity which is enclosed by a shell or casing of muscles, bones and skin. The cavity of the trunk is divided into two chambers, an upper and a lower. The upper chamber is called the chest, or *thorax*, and the lower the belly, or *abdomen*. The two chambers are separated by a partition or floor of muscle, the *diaphragm*.

In the *chest*, or upper chamber, are located two sets of organs, the heart and the lungs. Besides the many blood-vessels which are found in the chest, two principal tubes pass through it—the wind-pipe, or *trachea;* and the gullet, or *esophagus*.

The trachea leads from the back part of the mouth to the lungs, and carries the flood of air in and out as we breathe. At the top of the trachea is the "voice box," which can be felt as the Adam's apple at the front of the throat. The voice sounds are made by the air passing between two thin strips of membrane, called the vocal cords, stretched across the "voice box." Lying just back of the trachea is the gullet, which carries the food from the mouth to the stomach.

The *abdomen*, or lower and larger chamber of the trunk, contains the stomach, intestines, liver, kidneys, spleen and pancreas. The organs of the abdomen are protected at the back by the spinal column, the heavy

muscles of the back, and the ribs; at the sides by the ribs and pelvic, or hip, bones; and in front by the walls of muscle and the skin.

One must remember that besides the organs of the abdomen there are many blood-vessels and nerves passing through it to the different parts of the body.

The body can be trained to express joy, gladness, elation or any feeling

Fat is also freely stored up in this part of the body cavity, as you may know if you have ever seen the organs removed from the body of a fat pig. In fact, this fat is very valuable to protect and support the important organs of the abdomen.

Room for the organs.—The space provided by nature for the organs within the trunk is just large

enough for the organs to find room to do their best work. It is therefore highly important that we shall not crowd this space either by tight clothing, bad postures, or any wrong habits of work or play.

Respecting our bodies.—Do you not think that since nature has given us such wonderful bodies we should treat them well? Should we not respect them, and look upon them as worthy of our best care and attention? Should we not train them, and learn to control them, so that they may serve us well and perfectly carry out our thoughts and plans?

Some good resolutions to carry out.—1. I will not knowingly do anything that will injure my body or weaken any of its organs. Especially will I not poison its cells with alcohol and nicotine.

2. I will respect my body and keep it pure. I will have no habits that will weaken its powers or interfere with its skill and endurance.
3. I will obey the laws of health so far as I know them, and do all in my power to keep well and strong and free from sickness and disease.

Questions to answer.—How did many of the ancients look upon the body? What reasons have you for thinking they were not fair to the body? What are the three divisions or parts of the body? What parts

belong to the head? Tell why the hand is so important a part of the body. What two parts or cavities belong to the trunk? What organs are found in the chest? What organs are found in the abdomen? What is the name of the partition that separates the chest from the abdomen? Tell about the amount of space provided in the different chambers for the organs. Why do you think we should treat our bodies with respect? Give several good resolutions to make concerning our bodies.

Health Problems

1. The average length of life is nearly twice as great in this country as in India. Can you account for this difference?
2. It has been said that no machine has ever been invented which is as complex and wonderful as the body. What reasons can you give for believing this to be true?
3. Suppose every one would faithfully carry out the three good resolutions given on the opposite page, what results do you think would follow?
4. What are some of the principal ways in which people mistreat their bodies?
5. What occupations do you know of which are harmful to health?
6. More clerks and bookkeepers have tuberculosis than farmers or carpenters. Why?
7. Does your schoolroom supply good conditions for health? Does your home?

CHAPTER XXVI

DISEASE GERMS AND SICKNESS

Nearly everybody knows nowadays that most of our acute illnesses are caused by *microbes*, or disease germs.

These disease germs are all tiny living plants or animals. Each germ is composed of a single cell and is so small that it can be seen only through the microscope. The one-celled plant microbes are called *bacteria*. The one-celled animal microbes are called *protozoa*.

Millions of microbes.—As we learned in Book One, microbes are to be found all about us. The air is full of them. They swarm in water. They live in the soil by millions. Every grain of dust carries many of them. They attach themselves to our clothing, to our food, and even to our bodies.

Yet all these germs round about us need not worry us nor make us afraid. For the fact is, that of the three or four thousand kinds which we know only about fifty kinds of all the bacteria and protozoa can cause disease. Most of the microbes around us are not only entirely harmless, but are man's best

friends. Without them neither plants nor animals nor man could live.

How disease germs enter the body.—The microbes which are harmful to the body are called disease germs. Disease germs enter the body chiefly in three different ways:

(1) They get in through the skin where there are cuts, wounds, or punctures. Germs can not enter the body if the skin is unbroken.

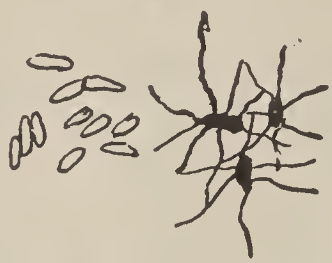
(2) Disease germs are usually taken in through the mouth, especially in food and drink.

(3) We may breathe in certain disease germs through the air, and so give them lodgment in the body.

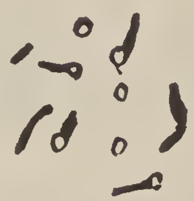
It is clear from these facts that to protect ourselves from germ diseases we have only to keep the germs from getting a hold in our bodies. For, no matter how many disease germs there may be in the world about us, not one of them will do us any harm unless it finds a way to enter the body and can there set up its growth.

Preventing disease by destroying the germs.—Disease germs being plants and animals, they must originally come from other plants and animals of the same kind. All disease germs are the offspring of other germs of the same species. The first great step in the prevention of disease is, therefore, to destroy as many disease germs from the body of the sick as possible, and not allow them to multiply.

If, for example, we could for a time destroy all the germs of tuberculosis coming from the bodies of those who have the disease; that is, if we could make every consumptive spit into a proper cup which would be burned or boiled, there would then be very little

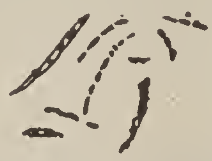


Typhoid germs



Germs causing tetanus (lockjaw)

tuberculosis anywhere in the world. For there is no place from which tuberculosis germs can come except to be reproduced from the germs already living in the bodies of their victims. And without the germs there would be no tuberculosis.



Tuberculosis germs

Pneumonia germs

If, in the same way we could capture and kill all the germs of smallpox, diphtheria, scarlet fever, measles, whooping cough, and such diseases as they come from the sick, we should then quickly be rid of the diseases themselves; for here again there would be no disease without the germs.

How we take disease.—No germ disease is ever caught except by taking into our bodies living germs which have recently come from others who have the disease. The germs of most contagious diseases, can live for but a short time outside the body of the person who has the disease.

Exposure to sunlight kills most germs in a few hours. All germs are killed by boiling water, but not by freezing; we may take a disease from using ice containing the germs. Many disinfectants, such as carbolic acid, formalin, or alcohol, will kill disease germs as soon as they touch them. In all of these ways, then, we may destroy disease germs and prevent them from giving the disease to others. Just as many disease germs as possible should be destroyed as they come from the bodies of the sick.

Ways of distributing disease germs.—Many people are very careless about giving disease germs to others. Yesterday, while on the street-car, I sat beside such a person. He was reading his paper when he was suddenly seized with a desire to sneeze. He sneezed loudly and violently, making so much noise that he attracted the attention of the whole car. Instead of being ashamed of himself for his bad manners, he seemed to think it was a joke and looked about with a smile.

What this man had really done was to *spit* thousands of little droplets of water from his mouth and his nose,

out into the air for other people to breathe! He had sprayed the air all around him with moisture that carried germs from his own nose and throat.

Many persons who are themselves well may chance to have in their mouth or nose the germs of a cold, of pneumonia, or even of tuberculosis. Surely no one has the right to cough or sneeze these out into the air for other people to breathe. If our friend on the car

Influenza germs as they may be seen in the laboratory

Influenza germs as found in sputum (spit) on the sidewalk

must sneeze, why does he not take his handkerchief and sneeze into that! If we must cough, shall we not cover our mouths, and not distribute germs to other people?

Germs and spitting.—Those who have the disgusting habit of spitting not only offend people of good taste, but they also give out whatever germs they may happen to have in their mouths. Then when the spit has dried and the germs are found floating in the air, other people must breathe them. Many diseases are spread in this way.

Most towns and cities now have laws against spitting in public places; yet there are still those who are rude enough to defile the sidewalks, and even the floors of public places, by spitting upon them. A recent item in a Boston paper tells of five men who had just been arrested and fined for spitting on the street. The laws against spitting should be rigidly enforced, but better still if people will break themselves of the filthy habit so that they would be ashamed to spit in public!

How germs cause sickness.—The ways in which different disease germs produce sickness in us is a most interesting story. As soon as a few of the germs have secured lodgment in the blood or in the tissues, they immediately begin to grow and reproduce their kind. The germs increase very rapidly. Many generations of them will come to life within the space of twenty-four hours.

Some of the germs, as in the case of diphtheria and lockjaw, produce toxins, or poisons, which we can easily collect and which would cause the disease if injected into the body without the germs. For example, enough poison is sometimes produced by the growth of small clumps of diphtheria germs on a patch the size of a dime in the throat to cause death. The tetanus, or lockjaw, germs do not leave the punctured wound, but they manufacture a poison which so affects the brain and nerves as to cause the muscles to become

rigid and set throughout the body. The toxins of the most of the disease germs can not be found separate from the germs themselves.

The germs of pneumonia multiply in the lungs, and their poison gets into the blood and poisons the entire body. The germs of tuberculosis devour by their toxins the lungs, or whatever organ they attack. The malarial germs destroy the red corpuscles of the blood, and so lessen the power of the blood to carry oxygen to the tissues.

But no matter how the disease microbes act to injure us, the damage all comes from the germs securing a hold in our bodies and multiplying there. We are not to think that the body does not resist the attack of hostile germs. The ways in which the body protects itself against these enemies is so important and interesting a story that we will take it up in a later lesson.

Interesting things to do.—1. Inquire of your family doctor or a member of your local Board of Health what diseases are required by law to be quarantined in your city or community.

2. Learn and report in class what are the laws in your state or town against spitting. How well are the laws obeyed?

3. A great deal of the coughing we do is unnecessary and could be easily controlled. If one must

clear his throat or cough this can be done with the mouth closed. Even sneezing can usually be checked. Let the class join in a contest to see who can for the longest time keep from coughing or sneezing in school; also outside of school.

Points to remember.—1. Disease germs can come to us only from the bodies of people or animals who have the disease.

2. Disease germs never harm us unless they enter our bodies. They may do this through the mouth, the nose, or through breaks in the skin.
3. The way to combat disease is to kill all the germs that come from the sick, and not let them reach well persons.
4. It is our duty to see that we do not help spread disease germs. We may spread disease by coughing, sneezing or spitting, or by carelessness about coming in contact with others when we are ill.

Questions to answer.—What two classes of microbes cause disease? What is the difference between bacteria and protozoa? Where are microbes to be found? What are the three principal ways in which disease germs may enter the body? Explain how disease can be prevented by destroying the germs. What is one way in which we could do away with tubercu-

losis, smallpox, diphtheria, and the like? From what source do the germs come that give us different diseases? In what different ways are disease germs distributed by those who are sick? Explain why people should not cough, sneeze or spit in public places. Explain how disease germs when once inside our bodies act to cause sickness.

Health Problems

1. How do disease germs cause sickness—what do they do to the body to make us sick?
2. How do we "catch" germ diseases?
3. Why is it that certain diseases, as scarlet fever, influenza or measles, are much lighter sometimes than other
4. In the Blank family the baby had scarlet fever, but was not very sick, so they did not call the doctor and no one outside of the family knew the baby was sick. Mary Blank went to school every day. What do you think the Blanks should have done when they found the baby had scarlet fever?
5. Suppose a diphtheria quarantine card is posted on your neighbor's house. Tell what persons were responsible for its being put up. Who says when it may come down?
6. What is the usual period of quarantine for scarlet fever? Smallpox? Whooping cough? Measles?

CHAPTER XXVII

GUARDING AGAINST DISEASE

Although there may be many disease germs around us, it is some satisfaction to know that there are but three principal gateways we must guard. As we learned in the preceding lesson, we shall be quite safe from germs if we can protect against them our mouth, our nose, and wounds in the skin.

Community responsibility for health.—Those of us who live in towns or cities can not always make sure of the cleanliness of our food and drink. That is to say, we can not go back to the farms, to the dairies, and to the source of water supply and make sure that the things we eat and drink do not bring us disease germs.

Town and city dwellers must depend more and more on the work done by public boards of health, health physicians, market inspectors, etc. Every great city, and, in fact, even towns and villages, now have their organized health agencies whose business it is to look out for the health of the citizens. It is the duty of all good citizens to help promote the health of their community.

A city's milk supply.—Those of us who live on farms and have our milk come fresh from the dairy each morning and night can hardly realize the difficulty in providing a fresh milk supply for a city.

The milk for city use must, of course, come from the farms. It is usually shipped in on special milk trains, many of which come from at least a hundred miles distance. After reaching the city, the milk has to be distributed to milk depots over the city. From there it is sent out in wagons and delivered to the customers. All this, of course, requires time, and very little milk reaches city users within twenty-four hours of the time it comes from the cows.

When the milking has been done with great cleanliness, the fresh milk has at the start about 2,500 bacteria for each cubic centimeter (a centimeter is little less than four-tenths of an inch; four cubic centimeters are one teaspoonful). As milk usually comes from the farm, however, it has not less than 30,000 bacteria to the cubic centimeter. If the milk is kept very cold the bacteria do not increase much within the first day; but if it is left luke-warm, there are likely to be about 5,000,000 bacteria to the cubic centimeter within twenty-four hours.

Germs in milk.—We are not to understand that most of these bacteria are disease germs; in fact, very few of them are. It is found, however, that milk which is full of bacteria is likely to be very bad for the health

of children. For this reason, every city now has strict regulations concerning its milk supply. It is unlawful in some cities to sell milk that contains more than 100,000 bacteria to each cubic centimeter.

Milk which has not been kept strictly fresh should be *pasteurized*. This means, as we learned in BOOK ONE, heating it to a temperature of 140 degrees Fahrenheit and keeping it at that temperature for twenty minutes. This will kill the bacteria of disease (but not the harmless ones which sour the milk), and will not injure the milk. It is therefore always best to pasteurize milk unless we know it is strictly fresh. Many prefer to boil the milk. That is an easier and surer way to kill the disease germs, but it changes the taste of the milk so that it is unpleasant to many.

Disease germs from public drinking cups.— Most states now have laws which forbid the use of the common drinking cup in public places. Yet it was only recently that in a railway station I saw a man come to the drinking tank and take a drink from the cup. This man wore dirty clothes, his hands were filthy with grease and dirt, and his mouth vile with tobacco juice. Worse still, there was a great sore on one of his lips. After he had put the cup down it was soon picked up by a child, who took a drink from it. Who knows how many disease germs were left on that cup by the man with soiled mouth and diseased lips,

and how many of these gained entrance into the mouth of the child!

We should never under any circumstances use a cup from which others have been drinking. Paper drinking cups are now commonly supplied in public places. Each of us should learn, however, how to make a drinking cup quickly and easily out of a clean sheet of paper.

Even the drinking fountain with its stream of flowing water is not safe if the lips are put down over the metal. Occasionally those who do not know how to drink from the flowing fountain drink with their mouths on the metal instead of holding their lips in the flowing stream.

Germs and the soda fountain.—Another source of danger from disease germs is the soda fountain. The glasses, dishes, and spoons used in these places are not always carefully washed. Frequently they are only dipped in cold water and carelessly dried on cloths that are none too clean. In this way many germs left by those who have had disease are left on the glasses and spoons, and so are given to other people.

Disease "carriers."—It has frequently been found that persons who have had certain diseases, such as typhoid fever, and have themselves perfectly recovered, are still infected with the germs of the disease, and for years can give them to other people. Those

who are themselves well, but are still infected by the germs of some disease, are called disease "carriers."

The harm that can be done by disease carriers is shown by the case of "Typhoid Mary," a woman who worked as a cook in New York. She for years had not had the slightest trace of typhoid herself, yet was proved finally to have given the disease to several persons, some of whom died. The California State Board of Health recently discovered a milkman who, though himself well, was a "carrier." He had given typhoid to over two hundred people. In Boston it was found that a nurse was a typhoid "carrier" and had brought the disease to several of her patients.

Disease "carriers" may give their germs over to others by handling their food or drink, by the use of drinking cups, towels, and napkins, or in other ways.

Besides the "carriers" who distribute disease germs, persons who believe themselves perfectly well may occasionally have germs of diphtheria, pneumonia, influenza, or tuberculosis in their mouths. These germs when taken by others may result in disease. Because of the danger of disease and also for the sake of personal cleanliness, there are certain rules that every person should follow.

Good rules to follow.—1. Keep your hands clean.

2. Never put pens, pencils, coins, or any other such articles in your mouth. Not only is this

an uncleanly habit, but it is a means of transmitting disease.

The house rat—always an enemy to man—destroying property and carrying disease

3. Do not share bites from apples or sticks of candy and, of course, never trade gum.
4. Break yourself of the soda fountain habit if you

have it; and if not, be sure not to form it. Not only is practically everything served there unnecessary when taken between meals, and therefore bad for the health, but the use of common dishes in most such places means the danger of disease.

5. Never use a common towel. If paper towels are not to be had in a public washroom, it is far better to use your handkerchief, or even allow your hands to dry in the air.

6. Make it a rule to keep all articles except clean, pure, necessary food out of the mouth. This will include your fingers, the corners of your books, or any other articles which you have a habit of putting into your mouth.

Rats and mice as disease carriers.—Rats and mice are among the worst pests known to man. It is estimated that rats and mice destroy each year in the United States property valued at over $200,000,000. This means that they are constantly destroying as much as an army of 200,000 men could earn.

But an even worse charge can be brought against the rat. It is known to carry from one place to another some of the worst diseases that afflict the human family. Rats catch a form of the "plague," and other serious diseases, and spread the infection wherever they go. The greatest care is used not to let rats from

an ocean-going ship land at the wharf, for fear of the diseases they may carry. It has been estimated that rats have caused, through the diseases they have carried, more deaths than all the wars of history.

Rats are one of man's worst enemies. They should have no quarter. Our houses and barns and warehouses should be so built as to afford them no place to live and no food to eat. Then we should hunt them and trap them and poison them and in every way seek to rid the world of the danger and destruction they bring. Mice are but little less objectionable than rats, and should be exterminated.

Questions to answer.—Why are city dwellers more dependent on health officers than those who live in the country? Explain how cities and towns are undertaking to protect the health of their citizens. Describe how a city gets its milk supply. Tell about the germs found in milk under differing conditions. When should milk be pasteurized? How is milk to be pasteurized? Give the case of the man and the little girl drinking from the same cup, and the lesson it teaches. What should be our rule about drinking from common cups? In what way may soda fountains help to spread disease? What is meant by disease carriers? Give several illustrations. What is said about disease germs sometimes being found in the mouths of well people? Why should this make us all the more careful about using common towels, drinking cups and the like?

CHAPTER XXVIII

THE BODY'S DEFENSES

The body is not helpless in the presence of its enemies, the disease germs. Far from it. Nor do we take disease every time the germs succeed in finding their way into our bodies. On the contrary, as we have learned, the germs of different diseases, such as diphtheria or pneumonia or tuberculosis, are often found in the mouths of persons who feel perfectly well. A great deal depends on the health of the nose, throat and mouth, for the mucous membrane of these cavities is almost like the skin, in that a germ can scarcely get through a healthy mucous membrane. But if it is diseased by catarrh, bad tonsils or bad teeth, then the germs have a much easier time getting into the tissues of the body.

Three modes of defense.—As a matter of fact, most disease germs have little chance even if they do succeed in getting into the body of a person who is naturally well and strong and who takes good care of his health. There are three principal ways in which the body defends itself against disease germs:

1. The healthy body is always producing *germicides*, or substances which can kill almost any germs.
2. The *white corpuscles* attack disease germs and destroy them.
3. The manufacture by the body of *antitoxins*. An antitoxin is the antidote to one, and only one, toxin or germ poison. The diphtheria antitoxin will protect us against the diphtheria germ, and against no other. So with the lockjaw antitoxin, etc.

Germicides in the blood.—Suppose that while you are at school to-day one of your friends is coughing and sneezing with an attack of the grippe, and that you are "exposed to the disease." To be exposed means that some of the germs have had a good chance to find their way into your body. What takes place within your body to defeat these germs and protect you from having the disease?

To begin with, our blood at all times contains substances which act to kill disease germs of every kind. These are called germicides. Under ordinary conditions these are able to protect us against the many infections to which we are daily exposed. Not depending on this, however, when the germs of a disease start their work, the body begins the manufacture of a special germicide to poison these particular germs, and no others. These are called antitoxins. It is the

rapid formation of these antitoxins which in an epidemic of scarlet fever, for illustration, prevents many persons who catch the disease (and who spread it) from feeling sick. For in any epidemic we believe there are a great many persons who really have the disease, but do not know it, since they feel just about as well as ever. It is thanks to protectors like these that we seldom have measles or typhoid fever more than once.

As soon as the effect of the grippe germs are felt, therefore, a special germicide appears in the blood for the destruction of the grippe germs. Your body does its best to escape its enemies by poisoning them.

White corpuscles ready to attack disease germs

The work of the white corpuscles.—One of the body's best defenses against the disease germs are the white corpuscles. We have already learned how these are always found in the blood circulation, and how they even find their way out through the walls of the capillaries and wander at will in the lymph among the tissues of the body.

It is the great business of the white corpuscles to act as defenders of the body against disease germs. They are the soldiers, or the police force, of the body. When the disease germs enter the blood or get into a wound through the skin, the white corpuscles flock in great numbers to the point of attack.

Each white corpuscle seems to select a particular disease germ and undertake to wrap itself around the germ and destroy it by absorbing or devouring it. Sometimes several white corpuscles together may join forces to attack a group of germs and surround them as a whole.

The *pus*, or matter, which comes from sores, is made up largely of the white corpuscles which have engaged in the fight against disease germs and have lost their lives in the struggle. In order to help the white corpuscles in their fight against the germs in a cut or wound, we use antiseptic washes, which help kill the germs and so aid the corpuscles in their battle.

We may think therefore of a constant battle going on within our blood-vessels and tissues between millions of white corpuscles and the disease germs which find their way into our bodies. The corpuscles never stop, even when the odds are against them, but like valiant soldiers, attack their enemies in deadly combat as long as they have life and strength.

Team work against disease.—In its fight against disease the forces of the body show fine team work. The germicides and the white corpuscles together launch an attack against the enemy. While the germicides weaken the germs and reduce their power of resistance, the white corpuscles strive to devour them completely.

Whatever disease germs escape the attack of these two defenders find that the body has a third line of defense. It is soon ready with an antidote of its own manufacture to fight whatever poison the germs may succeed in producing. By keeping up these three lines of defense the body usually triumphs over its disease enemies. The germs are all killed or their effects removed, and we recover. The body has then won its fight.

How we become immune from disease.—There are certain diseases which we are not likely to have more than once. For example, a person who has had smallpox rarely takes it a second time.

The same is true of typhoid fever and measles. When one is safe from again catching a disease he is said to be immune from it. We are immune from every disease we are recovering from for a little while at least. This immunity may last for life, as in the case of typhoid fever, measles, scarlet fever, and whooping cough, or for a few years only or for a few months, as diphtheria or pneumonia, or but for a few days, as in the case of a cold.

The reason for immunity against a disease we have had is not thoroughly understood, but in part, at least, is as follows: When the disease germs attack the body in the course of the disease a large supply of special antitoxin is manufactured, and also the body learns how to make it quickly. After the disease has passed,

some of this special germicide still remains in the blood, or can be furnished on short notice. As long as this is true, we are safe against this particular disease.

High and low resistance to disease.—You probably know some persons who rarely take diseases which are prevalent, and others who are almost certain to have every disease that comes along. Those who do not take diseases easily are said to have *high disease resistance;* those who take diseases easily, *low disease resistance.* This resistance to different diseases varies much with age. The child catches certain diseases easily which the grown person does not, and grown persons have some diseases which do not attack children.

As a rule, those who are well and strong and who have not injured their health by bad habits have a higher disease resistance than others of the same age who are not in good physical condition. This is precisely what we should expect, for only those whose bodily vigor is good can depend on a sufficient supply of germicides, white corpuscles and antitoxins to defeat the germ enemies which attack them.

Keeping our disease resistance high.—We shall, of course, keep out of the way of disease germs whenever we can. We will not knowingly expose ourselves to any contagious disease. Yet, do the best we may,

we can not always keep the germs from getting at us. Our safety therefore lies in keeping our disease resistance high. It is especially important that nose, mouth and throat be in healthy condition, for here is where most of the germs enter the body. Here is where the first battle is fought and usually won by the body. A diseased throat may allow the disease

Life in the open will insure these boy campers against falling easy prey to disease. And the fun itself is worth while

germ to locate here, grow, and get such a hold that the body will have a much harder battle, since many more germs will actually enter the body.

It is encouraging to know that when we are doing the best we can for our bodies in other ways we are also doing the best to protect it against disease. For the secret of high resistance to disease is only this:

(1) Keep the body clean and well nourished.

(2) Supply the lungs and skin with an abundance of fresh air.

(3) Take plenty of good exercise and abundant sleep.

(4) Have no bad habits that injure or weaken the organs.

Things that reduce resistance.—We have often heard of people who "worried themselves sick." Doctors tell us that those who most fear taking contagious diseases in epidemics are the ones most likely to be attacked, and if attacked are in great danger of dying. This is because all fear, worry and bad moods interfere with the work of the body in preparing its defenses. The body can not get ready its germicides and its antitoxins, and marshal its white corpuscle army if its vigor is reduced by worry and unhappiness.

One of the greatest enemies to high resistance to disease is alcohol.

It has been found that drinkers are much less able to resist such disease germs as those of pneumonia, typhoid fever and the like than those who have never used alcohol. This is because alcohol weakens all of our body's means of self-defense.

Even tobacco has been found to lower resistance to disease, and make one fall more easily a victim to the attacks of these germs upon his system.

Interesting points to consider.—1. Disease germs at certain times come in greater numbers and are also stronger and more vigorous than at other times. With this fact in mind can you explain why in some epidemics the disease is in mild form, while at another time the same disease may be very severe?

2. John and William were both exposed to measles by playing with a friend who had a mild form of the disease. Both John and William took the disease. John had a light case, while William nearly died of it. From the facts you have learned about how the body defends itself against disease germs, see if you can explain why William had the disease so much harder than John.

Questions to answer.—Does the body have any ways of defending itself against disease germs after they have once got a start? Mention three modes of defense against disease germs. What is meant by a *germicide?* Are germicides the same for all diseases? Tell the story of how the white corpuscles attack disease germs. What is the *pus*, or matter, that comes from sores? What is meant by *antitoxin?* How does the antitoxin act to defend the body against disease? What is meant by becoming *immune* to a disease? What makes us immune to certain diseases? Explain the difference between high resistance and low resist-

ance to disease. What causes the difference between high resistance and low resistance to disease? How may we keep our disease resistance high? Mention several things that tend to lower our disease resistance. Especially what effect has alcohol or tobacco upon disease resistance?

Health Problems

1. Two boys, Jack and Tim, went to visit their friend Mack who was sick. It turned out that Mack had scarlet fever. Jack caught the scarlet fever, but Tim did not. How can you explain why one boy caught the disease while the other escaped it?
2. Suppose a rat has been taken prisoner and you are the prosecuting lawyer to try the case. What are the counts you will bring up against him?
3. Imagine some diphtheria germs have got into the blood. Describe the various ways in which the body's defenders will attack the intruders.
4. What disease germs can be carried by a fly? By a mosquito?
5. Why is it that epidemics of disease often accompany or follow a time of famine?
6. What contagious diseases, which in the past often resulted in epidemics which killed thousands, are now well under control.

CHAPTER XXIX

VACCINATION AND THE PREVENTION OF DISEASE

Years ago smallpox was a much dreaded disease. Every year it claimed its tens of thousands of victims. Scarcely anybody escaped. Then Dr. Jenner, an English physician, made some very brave experiments that have been a great blessing to the world ever since; for his courage has freed us from the dread of smallpox.

How vaccination was discovered.—Dr. Jenner found that milkmaids often contracted from the cows a slight disease called *cowpox*. One of them told him that since she had once had cowpox she did not fear smallpox. This started Dr. Jenner to thinking, so he decided to try an experiment. He secured some of the *virus*, or matter, from the sores of a person who had the cowpox. He scratched this virus into the arm of a boy; the boy took the cowpox, but was not made very sick.

When the boy had fully recovered the doctor tried to give him smallpox by scratching some of the virus of this disease into his arm as he had done with the cowpox virus. But he could not make the boy take

the smallpox after he had had the cowpox. This proved that a person could be vaccinated against smallpox.

Dr. Pasteur, a French physician, tried the same kind of an experiment by placing some specially prepared germs of chicken cholera under the skin of well chickens. He found that the chickens would have a mild form of cholera without becoming very sick, and that this would keep them from having the disease in its dangerous form later. That is, he could vaccinate chickens against cholera. One of Pasteur's greatest discoveries was the cure by vaccination of hydrophobia, coming from the bite of a mad dog.

Vaccination against disease.—Out of such experiments as those of Dr. Jenner and Dr. Pasteur, the idea of vaccination against certain diseases arose. Vaccination is one of the most important discoveries that have ever been made for protecting us against disease. Its use has now become quite general, especially for smallpox, hydrophobia and typhoid fever. The result is that smallpox has almost entirely disappeared, and would completely disappear if every person would be vaccinated; while typhoid fever was scarcely met with during the last great war.

After learning how germicides work in the blood to combat the germs of disease, we can easily imagine how vaccination can protect us. The person who is vaccinated is really given a mild form of a very similar

disease, usually not severe enough to make him even feel sick. As soon as the disease begins, the body at once starts manufacturing the germicide required to destroy the germs, and can do it quickly in the future. Hence we do not again take the disease; we are immune. We call this immunity "active immunity," since the person manufactures his own antitoxin.

Why we should be vaccinated against smallpox.—Vaccination against smallpox is now compulsory in our army and navy. It is also required in many states before pupils can be admitted into the schools. In the recent European war the German army had almost no cases of smallpox, while the French army was troubled by this disease. The difference was caused by the fact that vaccination has been compulsory in Germany for many years and the German soldiers were all vaccinated, while the French were not.

There are some who still oppose, or are careless about, vaccination against smallpox. Such persons should remember that without vaccination, smallpox would to-day be a dreadful scourge, as it was in former times. Without vaccination smallpox would probably kill as many persons as tuberculosis does now. We should remember that vaccination *prevents* smallpox, and that if all would be vaccinated smallpox would entirely be done away with in a short time.

Being vaccinated is a very simple matter. It re-

quires no more pain than the scratch of a pin. Very few serious results ever follow from proper vaccination. The person who is vaccinated not only protects himself, but makes certain that he will not give the smallpox to others.

Where smallpox vaccine comes from.—Probably all the boys and girls who read this book have either been vaccinated or soon will be. It will therefore be interesting to know where the *vaccine*, or virus, that is put into your arm comes from.

Smallpox vaccine is obtained by planting the germs of cowpox in the skin of a young and healthy calf. This gives the calf the cowpox, and in a few days the skin is covered with blisters, which contain lymph filled with the germs of cowpox. Cowpox seems to be but an animal form of smallpox.

The lymph is taken from the skin of the calf and put into little glass tubes which are carefully sealed so that the air and dust can not get at them. The vaccine is then ready to plant in the arm of the person to be vaccinated; it will give him mild cowpox, and this will make him immune to smallpox.

Vaccination protects against typhoid fever.—Vaccination is also coming into common use to prevent typhoid. In the war between the United States and Spain in 1898, many more soldiers were killed by typhoid fever than were lost in battle. In the great

European war typhoid fever was almost unknown in the armies of France, Great Britain, and the United States. These nations vaccinate every soldier against typhoid.

As in the case of smallpox vaccination, vaccination against typhoid produces a mild illness, but not enough to cause serious trouble. The person who has been vaccinated with dead typhoid virus is immune to this disease for several years, but the effects of the vaccination do not last as long as the vaccination against smallpox.

Vaccination against other diseases.—The use of vaccination is extending to still other diseases. It has been used with success for the plague and for cholera; some think they have discovered vaccines against grippe, but we are not yet sure.

Prevention of diphtheria.—Until recently diphtheria has been counted one of our most dangerous and dreadful diseases. An *antitoxin* has, however, been discovered for diphtheria.

Diphtheria antitoxin is obtained by planting diphtheria germs in the blood of a horse and allowing the horse to develop a mild case of diphtheria. More and more germs are injected into the horse's veins from day to day until its blood becomes very strong in diphtheria antitoxin. The blood is then drawn from the veins of the horse and prepared for use in the human body. This horse's blood contains just what

your blood would contain if you had diphtheria and got well, only a great deal more of it. The horse has done the work of forming antitoxin for you.

If given early in a case of diphtheria, the antitoxin will always make the disease lighter and help in its cure. Well persons who are exposed to diphtheria should also take the antitoxin treatment, as it will in most cases prevent them from taking the disease.

Immunity from diphtheria by taking the antitoxin treatment lasts only for a few weeks, and not for several years, as is the case with smallpox or typhoid vaccination. Similar antitoxins are used in the prevention and cure of lockjaw and meningitis. We call this immunity "passive immunity," since the horse makes the antitoxin for us, not we for ourselves.

In order that you may understand clearly the difference between a serum and a vaccine, note this: A *vaccine* consists of the disease germs themselves; living, as in the case of cowpox and hydrophobia, or dead, as in the case of typhoid fever. These germs when injected stimulate us to make our own antitoxin. A serum is from the blood of a horse or patient who has had the disease. A serum contains no germs or toxins, but does provide a great deal of antitoxin "ready made" for us.

Interesting things to do.—1. Let each member of the class inquire at home and be able to give the following information:

(1) The date of his first vaccination for smallpox, and whether it "took."

(2) How many vaccinations all told he has had.

2. Compare the vaccination scar on your arm with any other scar to be found on your skin. Is the scar from vaccination deeper and unlike other scars?

3. Let the members of the class report whether they have ever had diphtheria. How many of the class have taken diphtheria antitoxin? Make the same report for typhoid.

4. If you do not already know from experience, inquire of your parents or the doctor how the doctor vaccinates (1) for smallpox, (2) for typhoid. Now, imagine that you are a doctor and show on a classmate how you would vaccinate him for each of the two.

Questions to answer.—Why was smallpox dreaded so much more many years ago than it is now? Tell the story of how Dr. Jenner discovered vaccination against smallpox. Tell about Dr. Pasteur's experiments in vaccinating chickens. How does vaccination keep us from taking a disease? How has vaccination shown its value in the case of soldiers? Tell how the *virus* for smallpox vaccination is obtained. What other diseases besides smallpox is vaccination used for? Tell how diphtheria antitoxin is secured.

CHAPTER XXX

COMMUNITY COOPERATION AND HEALTH

Every good citizen, whether young or old, feels some responsibility for his neighbor's health, happiness and well-being. What each one does and how he lives affects, in some measure, all the rest. Carelessness in one's own home or school or community may endanger the health or life of many others.

Responsibility for others.—For example, a serious epidemic of typhoid which caused the death of many persons was traced to the carelessness of one family where there was a case of this disease. Instead of treating the refuse from the body of the patient with carbolic acid or some other germicide before disposing of it, the refuse was emptied out on the grounds some distance away from the house. From here it was washed into a small stream and then the germs were carried on into a river from which a city drew its water supply. The result was that two hundred persons were sick and more than twenty lost their lives, all because the members of one family in the community were either ignorant or careless.

The home and community health.—Our homes are, of course, first of all for the members of our own families. We want them clean, pleasant and healthful for their occupants. But the home has also another responsibility. Each home is a part of a community, and should do its share to make the community a desirable place to live.

The home located in the open country, with no other homes near by, has a responsibility for the health of others differing from that of the town or city home. This country home may sell milk, butter, fruit, or other foods. If so, then the farmer should keep the food clean and free from disease germs. This will require clean barns, good water, and high standards of cleanliness in the handling of all food products. No filth or unclean drainage should be allowed to be carried into streams from which others may secure drinking water. The home and its surroundings should be kept neat, clean and attractive, so that they may be a source of pride to the owners and an example to others in the neighborhood. Nothing about the home should be offensive to neighbors or endanger the health of any person in the community.

The town or city home.—Those who have their homes in town or city communities have a still greater responsibility for the common welfare. This is because so many people are affected by anything that endangers public health. In some cities as many as two or

three thousand people live in a single tenement block. These families use common stairways, elevators and halls; they wash their clothes in the same laundry tubs; they depend on the same fire-escapes in case of fire; they are passing and repassing one another at close range every day of the year.

This all means that sickness, disease, uncleanliness or anything else that endangers one home will in some degree endanger many other homes as well. A contagious disease not properly cared for in one family may quickly spread until it has found victims in many families. Impurities, evil smells or poor housekeeping in one apartment make it unpleasant for other apartments near by.

All cities have a law forbidding any one to obstruct a fire-escape by placing upon it anything that might hinder its use in case of fire. Yet many lives are lost in cities every year because some one had placed furniture, bedding, boxes or the like on a fire-escape. It is well known that dust is dangerous to health, yet there are those living in crowded districts who will beat their rugs near other people's open windows or doors, or shake their rugs out of their own windows, and thus allow the germ-laden dust to enter their neighbors' houses. There are those who will throw garbage or refuse out into the alley or back yard thereby attracting flies and germs to annoy others or endanger their health.

Do you not think that each of us, whether he lives in city or country, should be a good enough citizen to make sure that nothing in or about his home shall annoy or endanger others?

The school and community health.—School is not only a place in which to train our minds, but also a place in which to train our bodies and make sure of health and strength. Every member of the school who is a good citizen will desire to do all he can to make the school free from danger to the health of every pupil. Here are some of the requirements of good citizenship in the school.

1. Every good citizen in the school is *clean*. This means having a clean body, clean clothes, clean speech, clean breath.
2. Good school citizens do not knowingly endanger others by coming to school when they have a contagious disease; by coughing or sneezing near others; or, when they have a sore throat, by putting anything in their mouths which others may touch.
3. Good school citizens help to keep the schoolhouse and premises clean. They do not needlessly carry in dirt or dust, nor litter the school room, toilets or yard with paper or other rubbish.
4. Every good citizen in the school will cheerfully do his part toward helping keep the room well

ventilated, the temperature right, the light properly adjusted, or take any other responsibility given him by the teacher for the common welfare.

5. No good school citizen will drink from a common cup when he has a sore throat, or a sore on the mouth or lips. Nor will he use a common towel or common wash basin when he has diseased eyes or skin.
6. No good school citizen will come to school after having had an infectious disease, or come from a home where others have an infectious disease, without first making sure by consulting a doctor that he will not give the disease to others.
7. All good school citizens will submit to vaccination, dental or other health examination, or any other measures planned by the public authorities for public health and safety.

The community and public health.—The community itself has many responsibilities for public health. All towns and cities and even most rural communities, have their boards of health, their public health physicians and nurses, their food inspectors, and other agencies to safeguard the health of their citizens. Some of the chief points at which the community, working through its health officers or through civic organizations, can provide for public health are:

1. The inspection of the conditions under which food is produced and sold. This will include the inspection of dairies, bakeries, ice-cream factories, and other places where food is prepared or marketed.
2. Making sure of a good water supply free from all danger of pollution from drainage which might bring to it disease germs or other impurities.
3. Clean streets and alleys, free from unnecessary dust, rubbish or refuse of any kind. All citizens, including boys and girls, should help in keeping their towns or cities clean and attractive.
4. Freedom from unnecessary noises, such as whistles from factories and locomotives, noisy traffic on residence streets, automobiles without mufflers, or other noises which may be avoided. It is known to all physicians that continuous noise is very trying, and will finally affect the health.
5. Freedom from unnecessary dangers, such as those from fires, from traffic, automobiles, etc. Thousands of persons are killed each year by accidents on our streets and roadways. The traffic policeman is now an important officer in every city, and all good citizens will do their best to cooperate with such officers for public safety.
6. Providing healthful conditions in factories, shops, offices, stores and other public places where peo-

ple work or assemble. This movement has resulted in better ventilated and better lighted factories and public buildings.

7. Providing health officers, hospitals, dispensaries and other agencies for protecting the health of the people. This also includes the providing of public playgrounds, parks and other places where the people can go for recreation and amusement.

Community health score card.—The score card which follows can be used in judging the health of your community. Before scoring any section of the community, note carefully each of the points, making sure that you understand just what it means and how the grading or marking should be done. Your teacher can help you on this. Different members of the class should score without consulting one another, and then compare results and discuss the difference in gradings.

	Perfect	Allow
HOME		
Drainage good; no pools; basement dry	10	....
Surroundings clean; no filth, manure, garbage, etc., about	10	....
Ventilation good; windows open for sleeping	20	....
Rugs; floors painted or oiled, no carpets	10	....
House well painted, attractive inside and out	10	....
Barns, dairies, outhouses, clean and well kept	20	....
Care to protect health; food well selected, doctor and dentist consulted when necessary; minor ailments looked after	20	....
	100	

	Perfect	Allow
SCHOOLHOUSE		
Well ventilated and lighted	20	....
Regularly cleaned	10	....
Well dusted; no feather dusters or dry cloths used	10	....
Sweeping compounds; no dry sweeping	10	....
Blackboards good, erasers and troughs free from chalk	10	....
Adequate space to play; apparatus	10	....
Pure drinking water; no common cups	10	....
Clean toilets and cloak rooms	10	....
Adequate fire protection	10	....
	100	
CHURCH AND SUNDAY SCHOOL		
Well ventilated	20	....
Heat right temperature, evenly distributed	20	....
Cleaned regularly	20	....
Dusting well done, no dry dusting	20	....
Bare floor or rugs; no carpets nailed down	10	....
Seats comfortable; no cushions	10	....
	100	
STREETS		
No open sewers	20	....
No pools or stagnant ponds neglected	10	....
No garbage or rubbish piled up	10	....
Swept and cleaned regularly	20	....
Sprinkled and flushed regularly	10	....
Baskets or cans provided for refuse	10	....
Traffic regulations obeyed	20	....
	100	

The class can easily extend this score card to make it apply to moving picture houses (include fire protection), factories, dairies, markets, or any other interests bearing on public health.

Questions to answer.—What reasons can you give to show that to be a good citizen each person must care for the well-being of all? What are several ways in which rural homes are responsible for public health? What are some of the principal points in which town and city homes should seek to promote neighborhood health? Give the several requirements of the good school citizen with respect to health. Tell the ways in which the community may promote the health of its citizens. Explain how to use the community health score card.

Health Problems

1. Some cities have a much lower death rate than others. What factors enter into this difference?
2. Has your community a good record for looking out for the health of its citizens? Name some of the enterprises for public health which it is carrying on.
3. Make a list of the ways in which boys and girls can help promote the health of their homes and communities.
4. There are some people who object to being vaccinated, saying it is their own affair if they wish to run the risk of smallpox. Is this fair to their community?
5. What conditions, if any, in your community (water, garbage, streets, markets) need to be remedied for the protection of health? Who are responsible in each case?

CHAPTER XXXI

MAKING SURE AGAINST TUBERCULOSIS

Ordinarily one should think about health rather than about disease. He should think about things that will make him well and strong and not worry about possible sickness. There is one disease, however, that is so widespread and dreadful that it deserves especial attention. This is tuberculosis.

Tuberculosis causes the death of more people than all other infectious diseases put together. About four hundred people die every day in the United States from tuberculosis. Tuberculosis is caused by a very small germ called the *tubercle bacillus*.

Facts we should know about tuberculosis.— One reason why it is important to study the question of tuberculosis is that the disease can often be prevented by very simple measures. Until a few years ago it was thought that tuberculosis could not be cured. Now we know that even if one has taken the disease it can in most cases be cured if taken in time.

Another mistake that was formerly made about tuberculosis was that it was believed to be hereditary; that is, people thought that children born of parents

who had tuberculosis would be almost certain to take the disease. Tuberculosis was therefore thought to run in families. But now we know that tuberculosis is never inherited; it does not come down as an inheritance from parents to children, but the baby certainly has a very easy chance to catch it from its parents during the first years of its life.

How tuberculosis is taken.—Tuberculosis can be contracted only by taking into the body the living germs from some person who has the disease. We may take the germs into our lungs through the air we breathe; or into our stomachs through milk or the food we eat; or, less frequently, through a break in the skin.

Those who have tuberculosis often are forced to cough a great deal. There is great danger that the germs from the lungs will be coughed out into the air that others must breathe, and so spread the disease. Especially is there danger when matter is coughed up and spit out. For the sputum (spit) soon dries and the germs float in the air.

A person who is ill with tuberculosis should always be supplied with a piece of cloth into which to cough, and the cloth should then be burned. Hospitals supply tuberculosis patients with covered paper cups to receive the sputum, which is then destroyed. Those who care for one sick with tuberculosis should always cleanse their hands thoroughly after handling clothing,

bedding, dishes or any other article used in the sick room.

Tuberculosis from animals.—A number of different animals are subject to tuberculosis. Many cows have the disease. Tuberculosis may be taken by drinking the milk of tuberculous cows, or from eating the meat of an animal that had the disease, if the meat has not been well cooked.

In some states all dairy herds are tested frequently for tuberculosis to make sure that infected milk is not being sold. Certain cities require milk to be pasteurized. Germs in tubercular meat are killed by thorough cooking.

The symptoms of tuberculosis.—Tuberculosis can be cured if taken in time. Cases of long standing seldom can be completely cured. It is therefore important that every one should know the early symptoms of the disease and not neglect any trouble that resembles tuberculosis.

One who has these symptoms should consult his doctor; they do not always mean tuberculosis, but it is better to be on the safe side:

(1) A cough that hangs on.
(2) Night sweats, with fever.
(3) Loss of weight, or failure to continue growth.

Curing tuberculosis.—If a person finds that he has tuberculosis he should not become discouraged and

give up. Thousands of persons with tuberculosis are cured every year.

Only those who live in houses have tuberculosis. Those who live out-of-doors are free from it. The germ thrives best in darkness and in stagnant air. Sunlight and fresh air are its worst enemies. Tuberculosis attacks those whose resistance to disease is low.

This Boy Scout is in small danger of tuberculosis —fresh air, sunlight and freedom from dust make him safe

These facts suggest the cure for tuberculosis. No known medicine will cure. The patient must have the following:

(1) Sunlight.

(2) Fresh air day and night.

(3) Plenty of good, nourishing food, especially fatty foods.

(4) Rest, sleep and quiet.

No doubt the thought has come to you that if these four things will *cure* tuberculosis they will also *prevent* it. And this is true. Possibly none of those who read this book may have had the symptoms of tuberculosis; it seldom develops in those under fifteen years of age. And yet many of you, doubtless, harbor the germ in

The Scout patrol is ready for a day's hike. Fun and health combined

your bodies. For this reason you should try to grow strong and sturdy. It is never a mistake to live in sunlight and fresh air, to eat plain nourishing food, and to make sure of sufficient rest and sleep.

Important facts to remember.—1. Tuberculosis causes more deaths than flood, famine, fire, earthquake, tornado and war combined. One-third of all the people who die between the

ages of twenty-five and forty-five die from tuberculosis.

2. Tuberculosis is not hereditary; it can always be prevented; it can be cured under right treatment if taken in time.
3. Prevention is better than cure. The time to prevent is when we are young. Then we will not have tuberculosis when we are older. A healthy body is the surest preventive against tuberculosis.
4. Tuberculosis attacks especially those who live in dark, poorly ventilated rooms. Also those who breathe much dust, and cramp their lungs by stooping postures. Sunlight and fresh air are insurance against tuberculosis.

Questions to answer.—What facts can you give showing how important it is that we know how to protect ourselves against tuberculosis? How is tuberculosis contracted? What measures may be taken to make sure that those who have tuberculosis do not give the disease to others? What animals are known to take tuberculosis? What measures do some states take to make sure that tuberculosis is not spread through the use of tubercular milk? What are some of the symptoms of tuberculosis? Describe the treatment by which tuberculosis is cured.

CHAPTER XXXII

PROTECTION AGAINST OTHER COMMON DISEASES

Some diseases are more likely to attack us when we are children, while others trouble us only when we are older. Among the diseases more common in childhood are, measles, scarlet fever, whooping cough, diphtheria, mumps, and chickenpox. These diseases are all contagious; that is, they are contracted from other people who have the disease.

Measles.—More people have measles than any other one disease. This is because measles is the most contagious disease of childhood and also because the disease is spread early, even before the one who has it realizes that he is ill. Almost every child who is exposed takes the disease. Nearly every one who will have measles has it before the age of fifteen, though occasionally the disease attacks adults.

There are certain well-marked symptoms by which measles can usually be known. One feels that he must sneeze and blow his nose; his eyes become red and watery; there is a cough and a feeling of chilliness. A rash comes out on the skin about the fourth day of the disease, beginning on the face and neck and soon extending to the trunk, arms and legs.

The best way to prevent measles is to keep away from those who have the disease. One who has just had measles, no matter how light the case, should not return to school without the doctor's directions. This is to protect others who may not have had the disease.

The troubles that follow a case of measles are often worse than the disease itself. The eyes are weakened, the ears often pain and sometimes have gatherings in them, the nose and throat are inflamed, and the lungs sometimes affected. One who is recovering from measles should have the best of care and should be particularly cautious about taking cold.

Scarlet Fever.—Scarlet fever is another germ disease very common in childhood. The disease is usually contracted by coming in contact with some one who has it, although the infection is also sometimes carried through the milk supply. The most common symptoms of scarlet fever are sudden fever, a sore throat, a rather severe headache, sickness at the stomach often accompanied by vomiting, and a feeling of chilliness. About twenty-four hours after these symptoms arise a red rash begins to appear, usually first on the neck and chest, and gradually spreading down to the arms, body and legs. After the disease is pretty well over the skin "peels."

Scarlet fever, like measles, often brings on other troubles. Some of these after-effects are rheumatism,

heart disease, inflammation of the glands of the neck, gatherings in the ear, and tonsilitis.

While in many communities measles is not quarantined, scarlet fever always is. One who has had scarlet fever will usually be a source of infection to others for five or six weeks. A physician, however, can tell when it is safe to remove the quarantine and allow the patient to go back to school.

Whooping cough.—Most of those who will ever have whooping cough have had it before the age of six years, hence this disease is not usually very troublesome in the school. Whooping cough is extremely contagious, and most young children who are exposed to it take the disease.

Whooping cough begins much like an ordinary cold or cough, but gradually grows more severe until one coughs so violently as to lose the breath quite completely. At the end of a spasm of coughing the breath is drawn in so shortly that the sound made is called a "whoop," which gives the name to the disease.

One of the worst things about whooping cough is that it lasts for about five or six weeks. Occasionally it may continue for several months and sometimes ends in pneumonia. No one who has a suspicious cold or cough, particularly if it is accompanied by a "whoop," should go to school without the consent of a physician, to make sure that he will not expose others.

Diphtheria.—Another disease which commonly comes before the age of twelve or fifteen, if at all, is diphtheria. Diphtheria may be taken by direct contact from those who have the disease, or it may be contracted from the common use of such articles as pencils, handkerchiefs, towels, and the like. It is also thought that infected milk may carry the germs.

The symptoms by which diphtheria is known are a rather high fever, headache, a feeling of great discomfort, chilliness, loss of appetite, sore throat, and whitish patches in the throat.

Although, as we learned in an earlier lesson, the antitoxin treatment greatly reduces the danger from this disease, every care should be taken to avoid having it, since it is likely to leave us with troubles affecting the eyes, the ears, the throat, or other organs. Cases of diphtheria are always quarantined, and the quarantine should be very strictly obeyed in order to protect others.

Mumps.—Mumps is a disease which one is most likely to take between the ages of five and fifteen. It may be called a school disease, since epidemics of it are very often found running through schools. The disease is spread by secretions coming from the nose and throat.

The symptoms of mumps are swelling of the glands at the angle of the jaw, a headache, pains in the back and sometimes in the legs. Vomiting and fever are

also common. The glands may swell on one side or both sides of the neck. It usually requires two or three days for the swelling to reach its height, and the disease commonly lasts from a week to ten days.

Chickenpox.—At one time it was thought that chickenpox was a mild form of smallpox, but it is now known that this is not the case.

It is fortunate that chickenpox is usually light and harmless, for it is not positively known how the disease is carried from one person to another. The symptoms by which the chickenpox is known are fever, loss of appetite, vomiting, and nose bleed. Several days after the fever begins a rash of small water blisters appears over the body.

One who has chickenpox should not go to school from the time the earliest symptoms appear until the scabs following the eruption on the skin have completely disappeared.

Hookworm disease.—There are several chronic diseases which do us much harm, and yet of whose presence the patient may be quite ignorant. One of them is the hookworm disease, especially common in some of the southern states. In certain districts nearly every person has this disease and yet very few realize that they are sick. Persons who have this disease are usually undersized, very pale and pasty in looks, are short of breath on any exertion and get tired very easily; in

fact, they are always tired and so are called lazy. But they are not really lazy; they are sick and do not realize it.

The cause of hookworm disease is a little white worm named from its shape, the hookworm, which is about a quarter of an inch long and looks like a short piece of thread. There are sometimes a few, sometimes thousands of these worms in the intestines of one man. There they stay, causing by their tiny bites little bleeding points on the wall of the bowel. If we examine with a microscope the bowel movements of these patients we find in it a lot of the tiny eggs of these worms.

As soon as a person finds he is thus afflicted he should at once begin treatment. If he does, he soon will be rid of the worms and then will get well. It is these tiny eggs which spread the disease, for after they are expelled from the body they hatch in the warm ground, setting free very tiny worms too small to be seen without a microscope. These eggs may cling to the feet of some barefooted child, burrow their way through the skin, causing as they do so, "ground itch." They are then carried by the blood to the lungs where they make their way into the air spaces, are coughed up with the sputum, then swallowed and develop in the bowel into the adult worm. You can see that one of the best ways to avoid this disease is to wear shoes and to keep the body, especially the hands, clean.

Interesting things to do.—1. Let each member of the class consult his parents and then make a list of all the infectious diseases he has had. In each case tell (1) at what age, (2) the source of exposure if known, (3) whether very sick, (4) how long the sickness lasted.

2. After investigating at home let each member of the class report whether there were any other troubles following an attack of disease, such as discharging ears, weak eyes, or rheumatism.

3. By inquiring of a physician or a member of a local board of health learn all the different diseases which are subject to quarantine in your community.

Questions to answer.—What are the diseases most commonly affecting children? How is measles contracted? What are the symptoms? What troubles sometimes follow a case of measles? At what age is scarlet fever most common? How may one take the disease? What are the symptoms? What are some of the bad effects? At what age is one most likely to have whooping cough? How may whooping cough be detected? What are the symptoms of diphtheria? What treatment greatly reduces the danger from diphtheria? How may diphtheria be conveyed? Describe a case of mumps. A case of chickenpox. Describe the hookworm disease. How is it taken?

CHAPTER XXXIII

THE SENSES

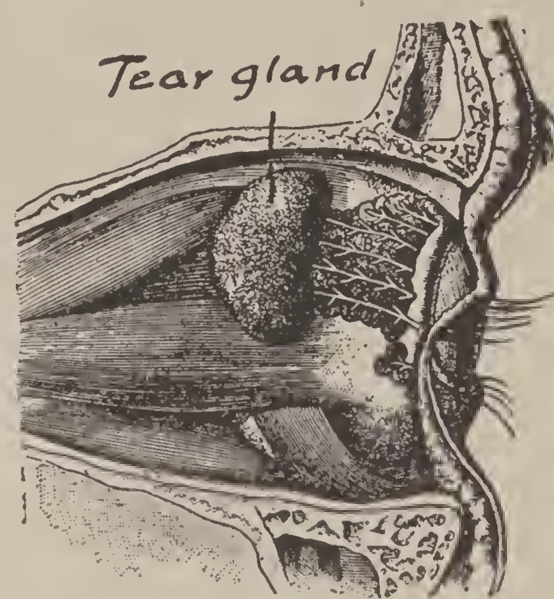
Some day when the lessons seem long and the tasks hard it will do us good to stop and think of Helen Keller.

From her earliest childhood Helen Keller has never been able to hear, nor to see. Her lack of sight kept her from coming to know the world of objects about her as we know them. Her lack of hearing kept her from learning to talk, for we first learn our speech by imitating the speech of others.

So when Helen had reached the age at which you began school, her mind was still very much a blank. Not only was she unable to talk, but she did not even know what speech meant. She did not know that things have names, and had not learned the name of a single object about her. She had no way of asking for what she wanted, or of making her needs known. She knew nothing whatever of the blue of the sky, the gold of the sunset, or the color of birds and flowers. She had never heard the sound of a voice, the song of a bird, nor the tones of music.

How Helen Keller learned.—In spite of being blind and deaf Helen Keller is to-day a finely educated young woman. She has graduated from college, knows several languages, and has written interesting books. In her book, *The Story of My Life*, which is very interesting to read, Miss Keller tells how she first came to learn.

Her teacher began by spelling words out with the tip of her finger on the palm of Helen's hand. In that way Helen learned the names of the common objects, such as her doll, kitten, chairs, and the names of people. Then she learned to read with her finger-tips by means of the raised letters used for the blind. Finally by holding the tips of her fingers on the lips and throat of any one speaking, she was able to read their words directly from their lips.



The eye, showing its muscles of control, the tear gland, and the bony socket in which it rests

Of course all this was very difficult. And those of us who can hear and see ought not to call any task hard when we remember that Helen Keller learned all the many things she knows without the use of either eyes or ears. We ought to be very thankful if we have perfect sensory organs, and ought to learn how to protect them.

The sensory organs.--Besides the *vital* organs, such as the heart and lungs, which are absolutely necessary to our life, we have another set of organs called the *senses*, or *sensory organs*.

The work of one group of the sensory organs is to keep us informed of what is going on *in the world about us*. The organs of this group are:

The nose and mouth cavities

(1) The *eye*, through which we come to know light, color, distance, direction, shape and size.

(2) The *ear*, through which we hear sounds, including not only the speech of those about us, but also all the sounds of nature.

(3) *Taste and smell*, through which we come to know the different tastes and odors. Through taste and smell we are not only able to enjoy our food, but also to judge its fitness for our use.

(4) *Warmth and cold*, through which we are able to judge temperatures, and so protect the body from the extremes of heat and cold.

(5) *Pain*, through which we are able to know when the body is being injured in any way.

(6) *Touch*, by means of which we are able to know when any object is in contact with some part of the body. Helen Keller has gained most of her education through the sense of touch in her finger-tips.

The work of another group of sensory organs is to keep us informed of what is going on *in the body itself*. The senses of this group are:

(1) The sense of *movement* and *strain* in our muscles and joints. It is through this sense that we are able to control the hand, as in writing, or in fact control the body in all its movements.

(2) The sense of *hunger* and *thirst*, by which we are able to know when the body needs food and drink.

(3) The sense of *equilibrium*, or balance, which is located in the ear, and through which we are able to balance the body, walking, standing or sitting.

How the sensory organs work.—Each of the senses requires some particular *stimulus* in order to set it going. By stimulus is meant anything that causes a sensory organ to act. For example, *light* is the stimulus required by the eye; *sound* is the stimulus required by the ear. Nor will any amount of sound cause the eye to see, nor light cause the ear to hear. Each organ must have its own proper stimulus.

The stimulus required by *taste* must be some substance that can be *dissolved*, and then come in fluid form to the taste organs located on the tongue.

The stimulus for *smell* is a substance that can be made to take the form of a *gas*, like air, and so reach the organs of smell in the nose as we breathe it in with the air.

The stimulus for *warmth* and *cold* and touch *must* in similar way be fitted to the needs of the sensory organ located in the skin.

Man and his senses.—The lowest forms of life do not have as many different senses as we have. The rule seems to be that each kind of animal has as many senses as it requires to live its own life. For example, fish which live in the waters of underground caves do not have eyes; for eyes would be useless in the dark. Very many of the lower types of animals do not have ears; for they do not need to hear. Certain other animal forms lack all sense of taste and smell; for they do not need them in selecting their food or for other purposes.

Man has many different senses because he needs them in order to live successfully and happily. The loss or injury of any sensory organ is a great handicap. Therefore one of our chief cares should be to understand each of our organs of sense, so that we may know and use it wisely and save it from injury.

Care of the sensory organs.—Most of the sensory organs do not require special care or attention. The sense of taste or smell is seldom injured. The sense of warmth and cold and the sense of touch may be injured or destroyed when a piece of skin containing their end organs is removed, as in the case of a burn or other accidents. Usually, however, the skin grows back on and no permanent harm is done.

The two sensory organs most liable to injury are *the eye* and *the ear.* These organs are so important that we will give them special attention in separate lessons.

Problems and experiments.—1. Those who are deaf, but have their sight, are now taught to read speech from the lips. Have some one speak a few words in so low a tone that you can not hear, and try to read what is said from his lips. Does it seem difficult?

2. Now try to read from the lips as Helen Keller does: Place the tips of the first two fingers on the lips of the speaker and your small finger at the same time on the front of the voice box. Can you recognize any words which are spoken? Does this seem harder than to read speech by watching the lips?
3. In spite of Helen Keller's fine education there are some things she can never know as you and I know them, simply because she has no sensory

organs through which to learn them. Make a list of experiences with which you are familiar, but which she can never have.

Questions to answer.—Tell the story of Helen Keller. How did Helen Keller first begin to learn the names of objects about her? How did Helen Keller finally learn to understand the speech of others? How does Helen Keller read books? What are the senses which give us knowledge of the world about us? What are the senses which give us knowledge of the body itself? What is the stimulus required by the eye? By the ear? By the organs of taste? By the organs of smell? Why does man have more sense organs than the lower forms of animal life? What are the two sense organs most liable to injury?

Health Problems

1. We used to speak of "the five senses," but we now know there are more than five. How many can you count?
2. Suppose one could feel no pain, would this be an advantage or a disadvantage?
3. What advantage is there in having the nose located directly over the mouth?
4. It has been found that Indians usually can see and hear better than white men. Why?
5. Why is it that when one has been sitting in a dark room and the light is suddenly turned on, it seems much brighter at first than it does after a few minutes?
6. Give illustrations of the same rule at work with other senses.

CHAPTER XXXIV

GOOD EYES

When you have been having your picture taken you have probably wondered what the photographer was looking at when he covered his head with a dark cloth and peered in at the back of the camera. Some day ask him to allow you to take a look into the camera, when some one is sitting in front of it. You may be surprised to see a perfect image, or picture, of the person on the glass at the back of the camera. And this image is always upside down!

The eye like a photographer's camera.—The eye works very much like a camera. In fact, the eye *is* a very small camera that operates itself. The lens in a photographer's camera causes an image of the one whose picture is taken to appear on the sensitive plate in the camera. A similar lens in your eye causes a small image of whatever object you see to form on a sensitive part at the back of your eye. We shall better understand how the eye works, if we first study its parts.

The eye is a ball about one inch in diameter. It fits in a bony socket of the skull, and rests against a pad of fat at the back.

The structure of the eye.—The eye is held in place and moved in the socket by six different muscles, which are attached to the eyeball. It is well supplied with blood by several large blood-vessels which enter

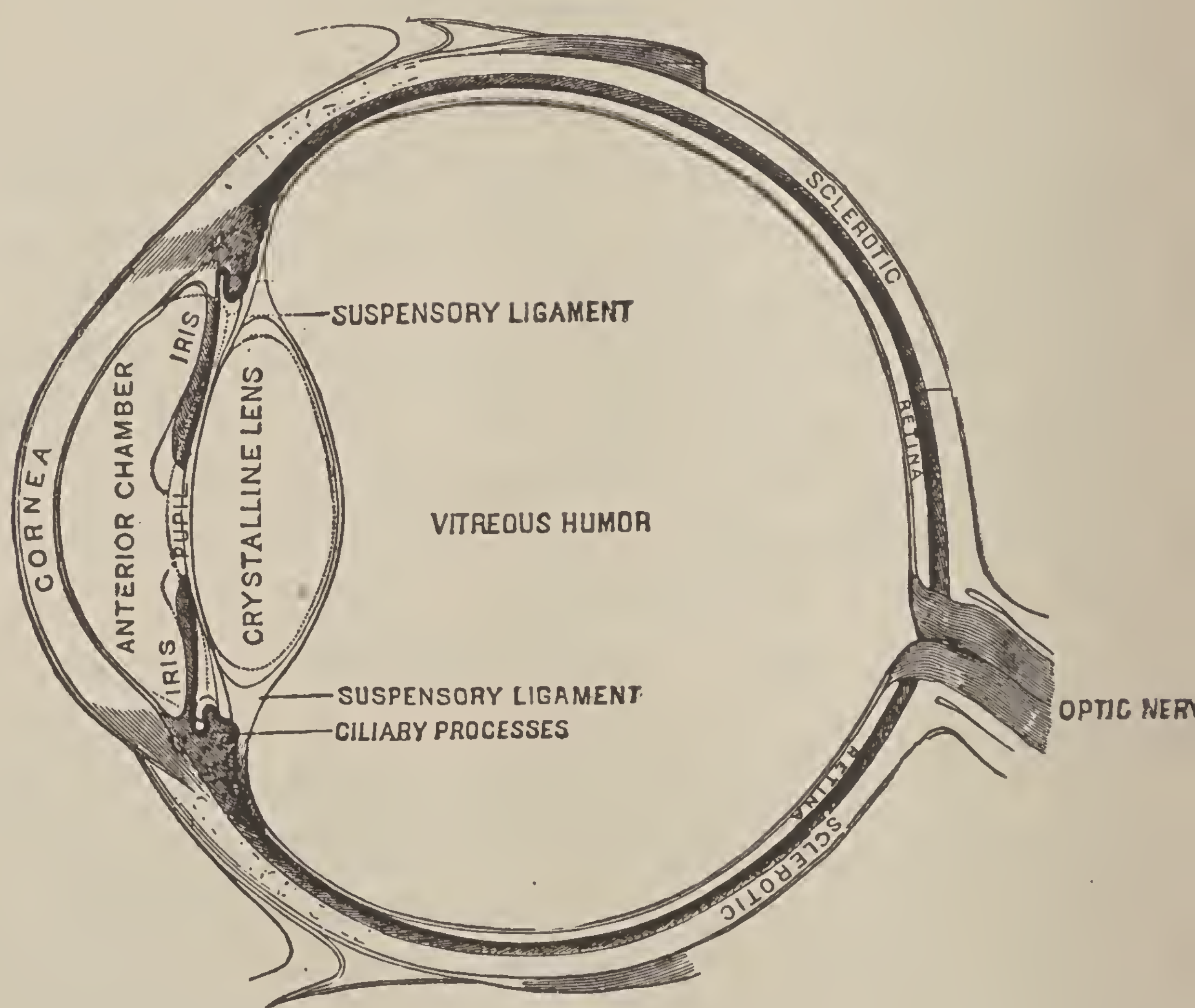


Diagram showing the parts of the eye

the ball from the rear. The nerve of sight, called the *optic nerve*, also enters the eye at the back.

What we see as the white of the eye is a tough, leathery cover. This coating is very strong. It contains all the inner parts of the eye and gives the eye

its shape. In the very front we see a transparent window, called the *cornea.* Stretched a little behind this is a curtain, called the *iris.* Through the center of the iris is a hole, called the *pupil*, through which the light passes. The coloring matter, which makes our eyes blue, or gray, or black, is spread over the front of the iris.

Inside the eye.—If we could follow the light through the pupil, we should find ourselves immediately passing through a very clear and transparent little body about the size of a small bean. This is the *lens.* The space back of the lens is filled with a clear jelly through which the light, after passing through the lens, goes on to the back part of the chamber.

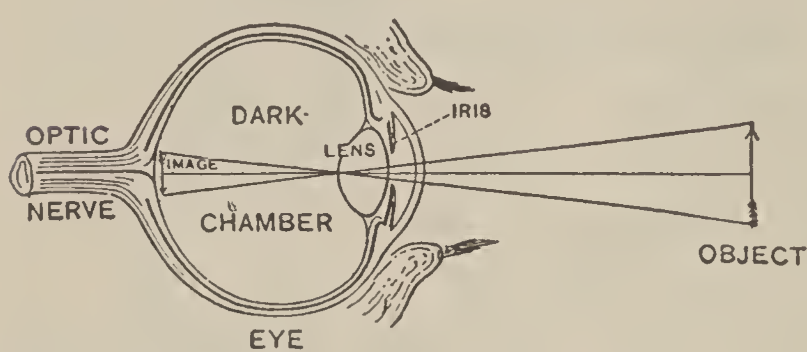
The spherical room inside the eye is lined with black, to keep out all the light except that which comes through the pupil. Over the rear half of the eye is spread the *retina*, which is made by the flattening out of the optic nerve as it enters the eyeball. In the retina are delicate little nerve endings, called *rods and cones.*

How we see.—When you look at an object, as a tree, the rays of light pass through the cornea, on through the pupil, then through the lens, and finally on to the retina at the back.

Here a perfect picture, or image, of the tree appears on a very sensitive group of the rods and cones. These send a message in to the brain, and you *see the tree!*

Seeing near and far objects.—You have probably noticed that when the photographer is about ready to take your picture, he turns a screw which moves the lens of the camera forward or back as may be required. This is to get a good *focus*. If the focus is not good your picture will be blurred and imperfect. If the focus is good, every line of your features will come out clear and sharp.

Now the eyeball can not change its shape in order to get a proper focus. But the lens inside has muscles which can change its shape, and this answers just the same purpose. When we are looking at an object far off, the lens becomes flatter. When we are looking at an object near by, the lens becomes more round, or convex. The reason the lens must change its shape for near and far objects is to produce a clear focus, or image, on the retina. If anything is wrong with the eye so that the focus is not clear, our sight will be blurred and indistinct, and we can not see well.



A diagram of the eye showing how the image of an object is formed on the sensitive nerve tissue at the back of the chamber

Why people need glasses.—A great many people have something wrong with the eyeball, or with the lens, which makes it impossible to secure a good focus.

If the eyeball or the lens is too flat, we say they are *far-sighted.* If, on the other hand, the eyeball or the lens is too much rounded, or convex, they are *near-sighted.* In either case glasses are required to correct the trouble.

Glasses are nothing but lenses to help the eye in producing a clear focus on the retina. The eye may have other defects than near-sightedness or far-sightedness; but whatever the trouble, it usually results in an imperfect focus, and the help of glasses is required.

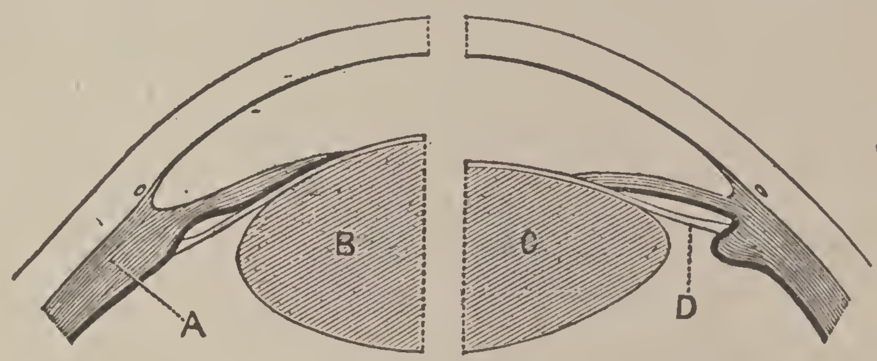


Diagram showing how the lens changes its shape for near and far objects. On the right the lens C is flattened by the pull of the ligament D, thus adapting it for distant vision. On the left the muscle A is acting, thus relaxing the ligament and allowing the lens to become more convex, for near vision

Whenever the eye is unable to focus properly, our sight is imperfect. It is possible for our eyes to be working improperly and we not be aware of it. There is great danger of seriously injuring the eyes if we continue to use them without glasses when they need the help which glasses would give.

Tests for eye trouble.—There are certain signs by which you may know that your eyes need attention:

1. Do your eyes smart, feel strained, or pain you when you have been using them for some time?
2. Do you have headaches and feel rather nervous when you continuously use your eyes?
3. Do the letters on the page you are reading ever look blurred? Do they dance about? Do they run together as you read?
4. Do you have trouble to read writing or figures on the blackboard or charts when other persons at the same distance seem to read the material without difficulty?

If your eyes act in any of these ways, you should have them examined by an oculist. He can easily tell whether you need glasses or not. It never pays to get along without glasses if we really need them; for this is sure, sooner or later, to injure our eyes permanently.

Taking care of the eyes.—Our eyes are so necessary, and have so much hard work to do, that we should give them the very best of care. The following are good rules for the care of the eyes:

1. Do not read too long at a time. Often an interesting story attracts us and we go on reading hour after hour, even when weary eyes tell us that we ought to quit. This is not fair to our eyes. Give them a rest now and then.
2. Do not read in a light that is too dim to see the print easily and clearly. On the other hand,

do not read in a light that is too bright, such as direct sunlight, or when sitting facing an electric lamp. In either case the eyes suffer injury.

3. Do not read, at least for any length of time, on a street-car or on a railway journey. The jolting about constantly requires changes of focus, and this exhausts the muscles of the eyes.
4. Do not read or work with the head bent forward, or with the eyes too close to the work. Bad postures not only overcharge the eyes with blood, but cause difficulty in focusing on objects that are too close. Keep your head erect and your book or your work at a proper distance.

Curtains protecting the eye.—The eyelids are two wonderful little curtains that have the power to adjust themselves to protect the eye. Let any danger threaten and the curtains quickly close over their precious charge. Let the light grow too strong and the eyelids close part way or shut entirely, as the case may require.

Winking the lids gently washes the eyeball and moistens it with a fluid which comes from small glands just above the eyeball. Pain or grief causes a more rapid flow of the fluid, and it then runs from our eyes (or discharges through a duct into our nose!) as tears. Closing the eyelids in winking also gives the eye a moment's rest from work and from the light.

Questions to answer.—Describe what may be seen on the plate at the back of a camera when a picture is being taken. Explain how the eye works like a camera. How is the eye held in place? How many muscles move the eye? Where does the nerve of sight enter the eye? Describe the cornea. The iris. The pupil. What is the work of the lens? Explain how we see. What takes place in the eye when we look from near to far objects? Why do some people need glasses? What are the signs by which we may know whether our eyes need attention? Give several rules for the care of the eyes. Explain how the eyes are protected by the lids and washed by the tears.

Health Problems

1. If you live in a city, watch one hundred people pass by you on the street. How many of them wear glasses?
2. Suppose glasses had never been invented, what difference would it have made to human life?
3. If you get a chance, take a camera to pieces and see how it works. Then compare the eye to a camera. What important points of difference are there?
4. What are the most frequent causes of blindness?
5. What are the different methods that have been invented to enable the blind to read?
6. What causes "cross-eye"? How does the surgeon sometimes cure crossed eyes by an operation?

CHAPTER XXXV

GOOD EARS

When we say that a person has large ears, or that he froze his ears in a blizzard, we mean of course the ear which can be seen. The really important part of the ear, however, the part where we actually hear, is hidden away in the bones of the skull.

The three parts of the ear.—The ear is made up of three distinct parts, each of which has its own particular work to do in causing us to hear. These parts are:

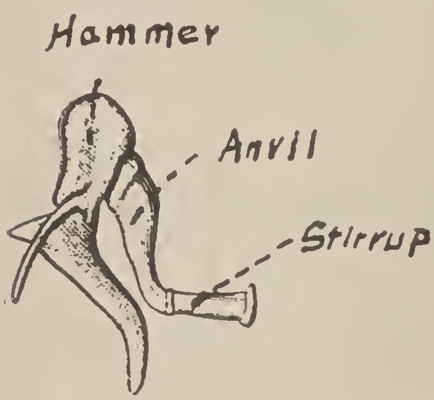
(1) The outer ear.
(2) The middle ear.
(3) The inner ear.

The outer ear.—The outer ear has two parts: (1) the shell attached to the side of the head, which we usually call the ear; and (2) the short tube or canal which leads into the head.

The outer shell of cartilage does not have much to do with our hearing, although it certainly helps a little in gathering waves of sound and turning them into the canal of the ear. Another use of the external part of the ear is to protect the delicate parts within. The

tube, or canal, part of the outer ear is about one inch in length. Across its inner end is stretched a thin membrane, called the *tympanum*, very much like the head of a drum.

The middle ear.—The middle ear is a small cavity in the bone of the skull. It is filled with air, which finds its way in through a tube that leads from the back of the mouth.

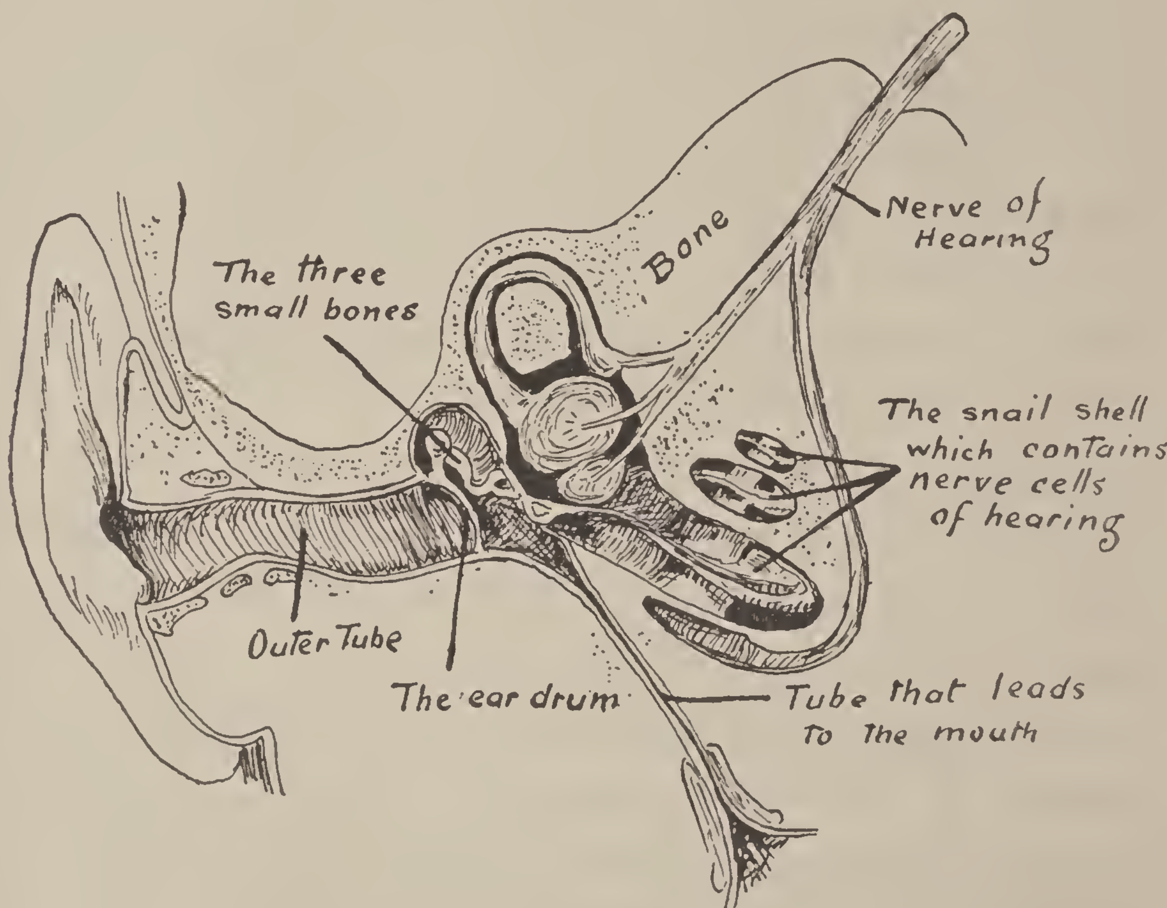


Stretching across the middle ear is a string of three tiny bones, called the *hammer*, the *anvil*, and the *stirrup*. The hammer is attached to the drum membrane at the end of the outer tube. The stirrup at the inner side of the cavity is connected with the inner ear; and the anvil connects the other two bones, thus completing the chain.

The inner ear.—The inner ear, like the middle ear, is found in a small bony cavity. This chamber is filled with lymph. The inner ear is shaped somewhat like a snail shell, with a winding canal, called the *cochlea*. In this canal are found thousands of the delicate sense organs of the auditory nerve. It is in the winding canal of the cochlea that the hearing is accomplished.

Besides the snail shell arrangement which contains

the cells of the auditory nerve, the inner ear also has three tiny canals each of which forms a half circle. They are therefore called the *semicircular canals.* It is the work of these canals that enables us to keep our balance, or equilibrium. Persons whose semicircular



A drawing of the right ear

canals have been destroyed stagger as they walk, and lose their sense of direction.

How we hear.—We have already learned that *light* is the stimulus for the eye, causing us to see. In a similar way, *sound* is the stimulus for the ear, enabling us to hear.

Whenever a sound is made, waves are caused in the air just as waves are produced in water when you drop a stone into the pool. The waves of air enter the ear through the outer canal; they strike the drum-head at the end of the canal and cause this to vibrate. The vibration of the membrane moves the chain of bones which hang across the middle ear. The last of these bones, the stirrup, is in contact with the liquid in the inner ear. The movement in the bones is therefore carried to the liquid in the inner ear. This affects the ends of the auditory nerves, causing them to send the message into the brain, and we then hear the sound.

Care of the ear.—The ear is not likely to be injured by over use as is the case with the eye. We may listen ever so long to ordinary sounds and the ear does not tire.

Very loud heavy sounds may, however, if too long continued, result in injury to the ear. Hardness of hearing frequently occurs among those who work in factories or other places where harsh, loud, heavy noises are continually heard. Loud explosive sounds may even drive the air waves against the ear-drum so violently as to break it and injure the hearing.

Gunners on battleships, or those serving heavy guns in battle, are required to hold their mouths open when the guns are fired. This allows the air from the middle ear to escape through the tube which leads into the mouth, and so make less strain on the ear-drum.

Hardness of hearing.—Hardness of hearing may be of all degrees, from deafness so slight as to be hardly noticed, to deafness so complete that one can not hear a gun fired by his ear. Most deafness is caused by disease, either in the middle or the inner ear. If the nerves of the inner ear are destroyed, one of course becomes entirely deaf.

Most partial deafness is caused by trouble in the middle ear. This usually comes from some disease or inflammation that causes the joints and membranes of the tiny bones of the middle ear so to harden that they can not properly do their work. The nerves of the inner ear may be ever so perfect, but if the sound waves can not be properly carried across to them, we of course can not hear well.

The throat and hearing.—As we have already learned, there is a tube that leads directly from the back part of the throat into the middle ear. The effects of sore throat, adenoids, or colds in the head, often extend to the middle ear. Bacteria may find their way up the tube, and cause pus, or matter, to form in the middle ear. The pressure of the pus sometimes breaks through the membrane, and then the ear "runs." A boy of my acquaintance has recently had influenza. As he was recovering from the disease his ear began to pain him, and in about a day pus began to discharge through a hole in the drum-head of his ear. His hearing was affected for a time, but as he soon recovered, the

hole in the membrane was repaired by new growth and his hearing was again perfect.

If inflammation is allowed to continue too long in the middle ear, the injury to the drum-head may become permanent or the membrane be entirely destroyed. There is danger also of this inflammation extending through to the inner ear and the brain, and causing serious trouble.

To make our hearing safe we must therefore keep the mouth and nose in good condition. This means to be free from catarrh and the tendency to sore throats. It means to get rid of bad tonsils and adenoids if we have them. It means to prevent our teeth from decaying and to have any cavities immediately taken care of. It means the prompt checking of all colds, and any troubles that cause the nose to run.

Care of the outer ear.—No part of the outer ear should have rough treatment. Blows on the ear or loud explosions near by endanger the drum membrane. The yellow wax which forms in the passage is given out by glands in the skin. Insects do not like the wax and therefore usually keep away from the ear.

Wax should be removed from the ear by a person himself only when it has reached the outer end of the tube and come into view. Hard objects, such as matches, pencils or toothpicks, should never be put into the ear for the removal of the wax. If the wax forms in a hard ball, a few drops of warm olive oil may

be put into the ear. This will usually soften the wax and allow it to come out.

Problems and experiments.—1. Do you ever have the earache? If so, does it usually come when you have been having a cold or sore throat?

2. How many of the class have had discharging ears? Ask your parents about this. Are there any who are troubled in this way at present?

3. How many of the class have had measles, scarlet fever, diphtheria, or pneumonia? Did ear trouble follow?

4. Do your ears ever feel full and stopped up? Do they have crackling or buzzing noises? If so, there is some trouble in the middle ear which you should see the doctor about.

5. An interesting experiment is to have the ears of the members of the class tested for sharpness of hearing. Your teacher can tell you how this should be done by listening (blindfolded) to the ticking of a watch as it is held at different distances from the ear.

Questions to answer.—What are the three different parts of the ear? Describe each of the two parts of the outer ear. How is the outer ear separated from the middle ear? Describe the middle ear. What is the use of the three small bones that hang across the middle ear? What is the use of the tube that leads

from the middle ear to the mouth? Describe the part of the inner ear in which the nerve of hearing ends. What work is performed by the semicircular canals of the inner ear? Tell how we hear. What care should be taken not to injure the ear? In what ways may deafness be caused? Explain how sore throat and bad tonsils may injure the ear.

Health Problems

1. Ask the doctor what are the most common causes of deafness. He will be glad to tell you.
2. Sit quietly where it is still and notice whether you can hear a buzzing or roaring or crackling in your ears. If you can you should have them examined by a doctor.
3. Explain how a diseased throat may cause trouble in the ears.
4. Lucy likes to hold her nose shut with her fingers, and then with her mouth closed blow to "feel her ears puff out." Why should this never be done? Demonstrate how to blow the nose without driving air back into the ears.
5. Why do not insects enter the ear canal and make us trouble by hiding there?
6. Persons who go up on high mountains or to high altitudes in an airplane usually have a strange sensation in their ears. What is the cause?
7. Deep sea divers and those who go down into deep mines also notice the effect on their ears. Is the cause the same?

CHAPTER XXXVI

THE CASE AGAINST ALCOHOL

In the different chapters of this book and in Book One we have been learning that alcohol is an enemy to the body. We have found that it always hinders and never helps.

In fact, we have in no place discovered any one saying a good word for alcohol. On the other hand, scientists, doctors, business men and other leaders unite in taking a stand against it. Let us now sum up the case against alcohol and see what our verdict should be.

Alcohol shortens life.—We have read how alcohol injures the different organs of the body; we have found that it weakens the heart; that it poisons the nerves and brain; that it injures the liver and the kidneys; and that it lowers resistance to disease.

Striking proof of these facts is found in a recent investigation made by forty-three different insurance companies of the United States. It was the purpose of the insurance companies to discover whether drinkers really die earlier than those who abstain from strong drink. Here are the facts they discovered:

1. Among very moderate drinkers the death rate was 18% greater than the average death rate.
2. Among those who had been drinkers, but who had reformed, the death rate was 50% greater than the average.
3. Among steady, moderate drinkers the death rate was 86% higher than the average.

Among all these groups of drinkers, it was found that the death rate from kidney diseases, pneumonia, and suicide, were higher than for normal people.

Whether the alcohol is taken in the form of beer, wine, or whisky does not seem to matter. The injury follows, no matter what the alcoholic drink. And even those who have reformed and quit drinking have to pay the penalty in a shortened life.

Laboratory experiments condemn alcohol.— Because scientists have desired to be fair to alcohol and not to condemn it without good cause, they have conducted many experiments in the laboratory to test its effect upon the body and the mind. These are some of the conclusions they have reached from their experiments:

1. Alcohol decreases the amount of work that one can do. This is true whether the work be physical labor, or whether it be skilled work like that of a compositor in setting type.
2. Alcohol interferes with mental work. Careful experiments have shown that beer or whisky or

any other form of alcohol will lower the intellectual power and make one unable to think clearly. It interferes with the memory, and makes one less accurate in everything from simple addition in arithmetic to solving of the hardest problems.

3. Alcohol reduces the power to withstand extreme cold or heat. It has been found that the warm glow felt after taking a drink of alcohol comes from driving the blood to the skin. But warming the skin results in cooling the interior of the body. In Polar expeditions all alcohol is absolutely forbidden, since its use is almost sure to lead to death from the cold. In hot weather the use of alcohol is also condemned, since it leads to a feeling of discomfort and makes one more liable to sunstrokes.

4. The drinking of alcohol results in a strong desire to continue its use. Alcohol is a habit-forming drug. One who has become accustomed to working under its effects feels that he must continually have it to spur him on. So the habit grows until it makes its victim a slave.

Alcohol condemned in war time.—Probably the most sweeping case ever made against alcohol has been made by the nations engaged in the world war which began in 1914. Every one of the great nations has taken steps either to forbid the use of alcohol or greatly restrict its use.

From the National Geographic Magazine, by special permission

Lieutenant René Fonck, one of the most celebrated of the French aviators. Lieutenant Fonck reveals the great secret of his marvelous success in these words: "One must be in constant training, always fit. . . . Alcohol becomes an enemy, even wine. All abuses must be avoided"

England, France, Russia and Germany all passed laws prohibiting the making or selling of certain kinds of alcoholic drinks. The United States did away with all intoxicants of every sort during the war, and now has prohibited their manufacture and sale by constitutional amendment. These are some of the reasons why the nations are driving alcohol out during war times:

1. Every nation desires its soldiers to be at their best during war. They must have clear brains, good endurance, and be as free as possible from sickness and disease. But alcohol clouds the brain, injures strength and endurance, and lowers resistance to disease.
2. During war each nation must make sure that all its citizens at home are doing their best through their work to produce food, guns and ammunition, clothing and everything else required in war. But liquor interferes with labor and decreases the amount of work that men can do. It never fails to lower efficiency, hence it must be driven out in time of war.
3. While war is going on there must be no wastage of food materials, since all are needed to feed the army and the citizens. But alcoholic drinks are made from the grains, fruits and vegetables we commonly use for food. Therefore all production of alcohol is a wastage of food supplies.

4. In time of war every citizen is expected to save his money and loan it to the government or pay it in taxes in order to provide for the cost of the war. But since alcohol is not a good food, and since it always injures those who use it, the money spent for strong drink is thrown away.
5. War brings to the people of a nation much suffering, sorrow and distress. But the use of alcohol is sure also to result in hardship and suffering. It brings unhappiness not only to the user but also to his family.

For these and many other reasons nations and governments set themselves against alcohol in time of war or other disaster. But if alcohol is not good for a nation when it is at war, can it be good for a nation when it is at peace! It is unlikely that any of the great nations of the present will go back to the free use of alcohol which was known before the recent war came on.

The case of business against alcohol.—The employer and the business man have no tolerance for alcohol. And there is no great business concern in the United States which does not frown on the use of alcohol by its employees.

Most railway companies will not keep a man in their employ who is known to drink. Leading factories plainly tell their men that a case of drunkenness will result in immediate discharge. In no business or

occupation will the use of alcohol help one toward promotion and success. In every vocation it will bar the way to success, and open wide the road to failure.

Other facts that condemn alcohol.—1. Before national prohibition went into effect it required the time and work of about 200,000 men to sell the liquor that is drunk in the United States. The saloons used 60,000,000 tons of coal a year, besides what was used in the manufacture of alcoholic drinks.

2. It is estimated that liquor has been causing the death either directly or indirectly of 200 men a day in the United States. One out of every eight who die in the United States loses his life as a direct or indirect result of alcohol.

3. The cost of liquor for any year in the United States has been more than ten times what is spent on all churches, and four times what is expended on the running of the public schools.

4. The use of alcohol causes accidents, sickness and death. It fills hospitals, poor-houses, insane asylums and prisons. It always corrupts the character and breaks down the manhood of the user. No good thing ever comes from its use.

The case against alcohol is so strong that our verdict must be *guilty!*—guilty of everything that is evil

and degrading, with no single good thing that can be said in its favor.

Questions to answer.—How do scientists, doctors and business men look upon the use of alcohol? What effect has alcohol upon the length of life? Give the facts discovered by the investigation made by insurance companies. What effect does the use of alcohol have on the amount of work that one can do? How does the use of alcohol affect the power to withstand extreme heat or cold? How do nations at war look upon the use of alcohol? For what reasons do governments oppose the use of alcohol in war times? What other reasons can you give why we should oppose the use of alcohol?

Health Problems

1. What is the eighteenth amendment? When did it go into effect?
2. What are some of the good results from prohibition?
3. What is "bootlegging" and what should be done about it?
4. A man bought whisky from a bootlegger, got drunk and killed a stranger whom he met on the street; was the person who sold the whisky also guilty of murder?
5. What is the opinion of most physicians as to the value of alcohol as a medicine?
6. Do you think the eighteenth amendment will be easier to enforce when the present younger generation is grown up? Why?

CHAPTER XXXVII

THE CASE AGAINST TOBACCO

Tobacco belongs to the same order of plants as the potato and the tomato. Yet tobacco contains a powerful poison—nicotine—while the potato and tomato are valuable foods.

No one knows when the use of tobacco began, but it seems to have been first used by the American Indian. In the sixteenth century the Spaniards began to cultivate tobacco as an ornamental plant. The French first used tobacco in the form of snuff. Soon it was widely used in different countries for smoking and chewing.

The governments of most countries first strongly opposed the use of tobacco. At one time smokers were punished in Russia by having their noses cut off.

Why people use tobacco.—Those who have learned to use tobacco are very much attached to it. Indeed, smokers and chewers of tobacco find the habit very hard to break.

Tobacco owes most of its charm to its *narcotic* effects. A narcotic is a drug which, in small doses, soothes and quiets the nerves and calms the mind.

In larger doses the narcotic drug may bring on artificial sleep, make one insensible to pain, and even cause death.

The nicotine of tobacco is a deadly poison. Enough nicotine is often found in one cigar to kill two men. Only a very small proportion of this poison is taken into the blood of the smoker, however, the remainder passing off in smoke as the cigar is burned. The United States Department of Agriculture has found that tobacco smoke contains about thirty per cent. of the nicotine originally in the cigar. Some poison is constantly being absorbed when one chews or smokes tobacco; for the pleasant and quieting effects produced depend upon the poison absorbed.

Tobacco and length of life.—The insurance companies have never made as extensive a study of the effects of tobacco as they have of alcohol. One insurance company, the New England Mutual, has, however, made a study of the effects of tobacco on the length of life, and published the results of their investigation. The study made by this company covered a period of sixty years and related to 180,000 persons insured. These are the facts discovered:

1. Occasional users of tobacco show a death rate 20% higher than abstainers.
2. Temperate users of tobacco show a death rate 42% higher than abstainers.

3. Heavier users of tobacco show a death rate 57% higher than abstainers.

From these facts it appears that the use of tobacco is almost as injurious to health and length of life as the use of alcohol.

Tobacco injures the body.—Of course, tobacco never kills outright those who use it; if it did this its use would quickly be forbidden. And it is undoubtedly true that a great many people who use tobacco live to a good old age; nevertheless we can not get away from the fact that tobacco does injure the body. It lowers resistance to disease, and leaves its victims less able to combat a siege of pneumonia, kidney trouble, or some other disorder that may attack them. These are some of the ways in which tobacco injures the body:

1. Tobacco affects the heart, and brings on a condition called "tobacco heart." The heart beats faster, the beating is irregular, pains are caused in the heart and the breath becomes short.

No wonder then that captains of football teams and athletic coaches all insist that their players let tobacco alone. But if tobacco is not good for an athlete, is it good for any one?

2. Surgeons have noticed that tobacco users do not rally as well after an operation as non-users.

One may say that he does not expect to have a

surgical operation, but even if he never does have one he needs, for many other purposes, the strength and vitality which tobacco is sure to rob him of.

3. Serious diseases of the nose, throat and ears are frequently traced to the use of tobacco.

Cancer of the throat, which has claimed many victims, is blamed by some physicians to the use of tobacco.

4. Smoking sometimes brings "tobacco blindness." Tobacco smoke also has a tendency to inflame the membranes of the eye, making them red and painful.

5. The use of tobacco lowers physical strength and endurance.

Boys who want to become athletes (and what boy does not?) will be interested in an investigation made in six different colleges and universities by Professor F. J. Pack to discover the relation of tobacco to success in football.

Professor Pack found that in these schools there were ninety-three smokers and one hundred seventeen non-smokers competing for places on the teams. Of the ninety-three smokers thirty-one, or thirty-three per cent., secured places. Of the one hundred seventeen non-smokers, seventy-nine, or sixty-seven per cent., secured places. The non-smokers therefore beat the smokers out by more than two to one. Professor Pack's conclusions are:

(1) Only half as many smokers as non-smokers are successful in football competition.

The man who expects to equal or beat this record can not be a user of tobacco while in training

(2) Smoking is accompanied by a loss of lung capacity amounting to about ten per cent.

Tobacco interferes with mental work.—Tobacco interferes with the best mental work as it does with

physical health and strength. It is found in schools everywhere that the use of tobacco is accompanied by a low average of scholarship.

For example, among the football men studied by Professor Pack, the average of the grades of the non-smokers was markedly higher than the grades of the smokers. From twelve other colleges comes the report that twice as many failures in studies are made by smokers as by non-smokers. If tobacco interferes with scholarship with men of college age, it will surely hinder still more the mental development of the younger boys in the grades and high schools.

Why should boys injure their chance of success by dulling their brains with tobacco while getting their education!

Still other counts against tobacco.—1. The use of tobacco wastes time. Watch the smoker as he stops his work, his reading, or his study to light his pipe, his cigarette, or his cigar. Attention is always broken into and time lost.

2. Tobacco costs money. Many persons are spending money for tobacco which might better go into books, travel, education or the savings bank.
3. Tobacco using is an uncleanly habit. It dirties the mouth, poisons the breath, and makes one generally disagreeable to those who do not use tobacco. One look into a public smoking room,

or the smoking car on the train, is enough to condemn the use of tobacco for all who care to be clean and attractive.

Questions to answer.—To what common food plants is tobacco related? Give an account of the first use made of tobacco. What is a *narcotic?* What is the principal poison found in tobacco? Why do users of tobacco enjoy it? What facts were shown by the insurance investigation about the use of tobacco and the length of life? In what different ways is tobacco known to injure the body? What facts were discovered by Professor Pack about the use of tobacco and football success? How does the use of tobacco affect mental work? Are there still other reasons why the tobacco habit should be condemned?

Health Problems

1. Although many seemingly well persons use tobacco, scientists tell us it is an enemy to health, that it lowers brain power and shortens life. Can a boy who wants to succeed afford the handicap?
2. Try asking fifty or one hundred men smokers whether they would advise a boy to begin smoking. What answers do you get?
3. We spend in this country far more money on tobacco than on education. What do you think about the wisdom of this? Could your school use more money for equipment, books, etc.?
4. Do you believe the law should prohibit the sale of tobacco to minors?

CHAPTER XXXVIII

IN THE SICK ROOM

Do the best we may, some one occasionally becomes ill in our home. The sick room then becomes the center of anxious care, and every member of the family tries to do his best to make everything as favorable as possible for recovery.

The sick room should be quiet.—I know a boy whose mother is ill. Tom loves his mother and is very much concerned over her sickness. He longs to have her well, and each day he inquires whether she is not getting better.

In spite of this, however, Tom is sometimes noisy about the house. He forgets and slams doors, or he drops something on the floor, or he tramps heavily when he walks. Nothing is farther from Tom's intentions than to do anything to hurt his mother. Yet all of these things do hurt her, and make her recovery more difficult.

It is sometimes hard for those who are well to realize what a difference sickness makes. The nerves become sensitive, and the least sudden shock causes pain and suffering; the mood becomes irritable, and

small pains that ordinarily would not be noticed disturb and annoy. Everything should be done to make the sick person comfortable, calm and quiet.

Cheerfulness in the sick room.—Every one about the sick room should show cheerfulness, bravery and courage. Nothing can trouble a sick person much more than to have around him those who are worried, unhappy, or depressed in their actions.

The conversation in the sick room should be in a natural, quiet tone and not in mysterious whispers. The sickness, trouble or death of other people should never form the topic of conversation in the sick room, as this tends to disturb and annoy one who is ill.

Cleanliness in the sick room.—When we remember that germs of all kinds thrive best in dirt, dampness and decay, and that germs are easily carried on particles of dust, we easily understand why the sick room should be the cleanest place of the house. The room should be full of fresh, moving air and should be flooded with sunshine.

Furnishings for the sick room.—All furnishings which are not absolutely necessary for the care of the patient should be removed from the sick room. The floor should be bare, or at most have a few small rugs that may easily be taken out and cleaned. There should be no heavy curtains or hangings to gather dust and make a hiding place for germs.

No clothing should be left hanging in an adjoining closet or left about the room.

Protecting from infection.—Whenever an infectious disease is in the house, the greatest care should be taken not to expose others. Even in such diseases as severe colds, influenza, or measles, which are not usually quarantined, care should still be taken.

Separate dishes should be used for the sick, and these dishes should not be washed with the family supply. After caring for a sick person, changing the bed, or cleaning the room, the hands should thoroughly be washed in soap and hot water. If the disease is contagious the hands should be sterilized, after being washed, with alcohol or a weak solution of carbolic acid.

Disinfecting a sick room.—After a patient has recovered from a contagious disease, one of the most important problems still remains. This is to disinfect the sick room, bedding and other articles that the disease may not spread to others.

If the sickness has been one that is quarantined, the physician or health officer will give directions for disinfecting. Such directions should be strictly followed. It is well, however, even in such diseases as measles, pneumonia and influenza, to disinfect after a case of sickness, though these diseases are not quarantined.

One of the methods commonly used for disinfecting a room is to close as tightly as possible all of the cracks

around windows and doors, and then expose in the room for about twenty-four hours an open dish containing a strong solution of *formalin*. But this does very little good. It is not nearly so efficient as a good scrubbing of the walls and floor with soap and water.

All articles of clothing and bedding, which will not be injured by boiling, should be thoroughly boiled, as this will kill all the disease germs. We are not to forget that sunlight is one of the best germicides that has ever been discovered. Mattresses and such articles of clothing as can not be washed should be exposed to bright sunshine for two or three days.

Interesting things to do.—1. Let each member of the class report any experience of being ill for several days. When you were sick were you annoyed by sudden noises, loud voices or other disturbing things which ordinarily you would not notice? Were you good natured or were you rather fretful and cross? Did you expect people to be good and kind to you because you were sick?

2. Inquire of some member of your family or other person who has recently been ill whether when he is sick he likes talkative callers. Whether he likes visitors who talk about sickness, disease and trouble while they are visiting him. Whether he desires every one around the sick room to be cheerful and natural.

3. After inquiring of your parents, a doctor, or a member of your local board of health, make a list of all the diseases which are required by law to be quarantined in your city or community. What are the quarantine signs of these diseases?
4. Make a list of the ways in which boys and girls can be helpful around the house when there is sickness.

Questions to answer.—Give the case of Tom and his mother, who was ill. What effect does sickness have upon the nerves and disposition? What should be the manner of those who are about the sick room? Why should the sick room be kept especially clean? Describe the furnishings best adapted to the sick room. What measures should be taken to protect others from contagion? Give directions as to how to disinfect after a case of sickness.

Health Problems

1. Describe the kind of room you would like if you were to be sick for some time; the kind of attendance you would like.
2. One notices that hospitals always have few rugs or draperies, and that everything is shiny clean. Why are they furnished and kept in this way?
3. What unnecessary noises are there in your city which are annoying to sick persons?
4. Why should one who is sick try to keep cheerful and hopeful?

CHAPTER XXXIX

KEEPING COOL IN EMERGENCIES

Did you ever stop to think what difference it makes whether in some kind of excitement or danger one does the right thing or the wrong thing?

Several years ago in a western city, a large audience of children were assembled on Christmas Eve for a program and entertainment. It was never discovered who was to blame, but in the midst of the program some one at the back of the audience shouted fire.

Now there was no fire nor even any smoke. Some one for a silly joke or some other purpose had given a false alarm. Immediately there was a panic and a wild rush for the doors. The entertainment was held on the second floor of the building, and the stairway was quickly jammed with a screaming, terrified mass.

When the crowd was at last out and the police had succeeded in clearing up the pile of crushed and injured at the bottom of the stairs, it was found that more than a score of people, mostly children, had lost their lives. What made it seem particularly sad was that it was all so unnecessary. First, there was the foolish giving of the false alarm; and following that

was the equally foolish panic which occurred because the people had not learned to control themselves.

Keeping one's head in emergencies.—When we read the story of some brave deed or heroic rescue that has saved a life, we all feel that we would like to be heroes ourselves and do such things. While there are many different kinds of heroes, one thing seems to be true of all of them: they keep cool in times of danger or excitement. Heroes do not lose their heads and do foolish or unnecessary things.

A paragraph in a newspaper before me illustrates this point. Two boys, one eight and the other eleven years of age, live in an apartment house in the city of Boston. One afternoon as they came home from school and entered the hallway, they saw smoke pouring out of the transom above the door of a neighboring apartment. Quick as a flash they rushed into the room. There they found two small children almost suffocated. They dragged them outside and down into the street. Then they ran and gave the fire alarm. A fire company quickly came and put out the fire, and there was no great damage done.

Had these boys become excited and not known what to do, it is likely that the two children whom they rescued would have lost their lives. And surely our young friends would have lost the chance to show themselves heroes who can keep their heads in emergencies.

Saving seconds.—Often the promptness with which one acts may save a life. In rescuing a drowning person it is necessary to do something at once when he has been brought from the water. Every second counts. To wait for the arrival of the doctor or some other person who knows what to do may mean the difference between life and death.

Do not use candles on a Christmas tree. Many lives have been lost by Christmas tree fires

The same need for quick action exists when poisons have been taken, when there is serious bleeding from a cut or wound, or when some one has been suffocated by breathing gas.

Knowing the right thing to do.—If one is to keep calm and work fast in emergencies he must first of all know just what to do. When the emergency comes it is too late to learn, for there is no time.

No boy or girl can tell when the chance may come to save a life by using knowledge and skill. Let each

of us ask ourselves the question: Would I know what to do in some of the more common emergencies? Would I know how to treat a person who has been rescued from drowning? Would I know what to do if a companion had broken his leg? Would I know what to do in a case of poisoning? Would I know what to do in case of severe bleeding?

Skill through practise.—I suppose many of those who study this lesson are in schools where there is regular fire drill. You are taught to obey signals, to march, and perhaps to use the fire-escapes. You go through these drills time after time, although no fire has ever occurred in your building.

In similar way soldiers are drilled day after day and week after week in marching, handling their fire-arms, and doing everything else that a soldier has to do. This drill is carried on until the soldier's movements become almost second nature to him, so that he can do them without thinking.

Drill is the only way to make sure of calmness and skill in times of emergency or danger. It is for this reason that Boy Scouts and Girl Scouts are given practical training in what to do in all the common emergencies.

In the lesson which follows suggestions will be given for training and practise which will enable you to know what to do when the chance comes to show yourself a hero in some emergency.

Interesting things to do.—1. Let each member of the class write or tell the story of some accident or exciting incident with which he was connected. Did you know what to do? Did you keep cool? Did you do the right thing? What should you have done differently?

2. Let each member of the class tell the bravest thing you ever saw done. The narrowest escape you ever saw any one have. Did the person concerned keep cool and act wisely in each case?

Questions to answer.—Tell the story of the fire alarm at the Christmas exercises. What two great mistakes were made on this occasion? What is one of the first qualities that one should have in a case of emergency? Give the case showing how the cool-headedness of two boys saved the children from burning to death. Why is it necessary to act promptly in many cases of emergency? Why is it necessary that we should learn beforehand what to do in the case of certain emergencies? Why should we practise doing certain of the things beforehand which may need to be done in emergencies?

Health Problems

1. It has been found that Scouts are usually cool-headed in emergencies. How is this to be accounted for?
2. At a place where a house took fire, a woman threw a mirror out of a second story window and carried a mattress down the stairs. Account for her strange action.

CHAPTER XL

WHAT TO DO IN EMERGENCIES

It is not enough that we should *merely learn* what to do in emergencies. If you are to be able to use your knowledge when the emergency comes, you must *actually do* over and over again in practise the things to be done in the emergency until you can do them quickly and skilfully without excitement.

This lesson therefore tells you how to do certain things that should be done in emergencies.

Drowning.—Every American boy and girl should know how to swim. This is worth while, first of all, for the pleasure it gives. But aside from that we ought to know how to swim in order to be able to save our own lives or the lives of others in case of emergencies in water.

A drowning person when taken from the water is not breathing, and the failure to take air into the lungs has partially or even wholly stopped the action of the heart. The first thing necessary, therefore, is to get the breathing and the circulation started again.

To do this, place the patient flat on his stomach. Have his head turned to one side, and lower than the

rest of his body so that the water can drain from the lungs. Take a position like that shown in the picture, with the thumbs nearly meeting on the small of the patient's back, and with the fingers clasping the sides

Producing artificial breathing in case of drowning

at the small ribs. Now swing your body forward, pressing with your weight and the grip of your hands on the small of the back and the side. Then immediately swing your body backward releasing the pressure. Do this regularly about twelve times a minute, and

keep it up! Do not get discouraged. Life has been known to return after more than an hour of such work during which no sign of consciousness had been shown.

If other help is at hand, some one should at once be sent for dry blankets, while others are rubbing the arms and legs to help start the circulation. While recovering the patient should have hot water bottles at the feet and be kept warmly covered.

Carrying an injured person.—A person who has been seriously injured or has broken bones should ordinarily not be carried. The best thing to do in such a case is to straighten the injured person out in a comfortable position, cover with a blanket or with extra clothing, and immediately send for help.

Two different kinds of seats are easily made for carrying the injured. One is formed by tying the corners of a handkerchief together, making out of it a ring. Each of the two who are to carry then takes hold of the ring, the patient resting on the seat between them.

A second method, if a blanket is to be had, is to tie together the diagonally opposite corners. Those who are to do the carrying place the ring over their heads. This method leaves the hands free to help support the patient.

If a blanket is at hand a stretcher may be quickly made by rolling each of the edges around two sticks

tightly enough that it will not slip. If no blanket is available a stretcher may be made by taking two coats, buttoning them, and then passing poles through the bodies of the coats.

Many destructive fires are started by children setting bonfires in dangerous places. Never start a fire near houses, barns, wooden fences or other inflammable material

When clothing takes fire.—If we remember two things they will help us understand what to do in case our clothing catches fire:

(1) Fire will continue to burn *only when it has air.*

(2) Flames always have a *tendency to leap upward* and not downward.

A person whose clothing is on fire should never start to run. This only fans the flames by giving them air. The thing to do is to drop instantly to the floor and roll over and over; or better still to roll up in a rug or in bed covering. In this way the flames are smothered for want of air and the fire put out.

The first thing necessary in treating serious burns is to keep the air away from them. If a large portion of the body has been burned, there is no better way than to put the patient into a tub of warm water, clothes and all, until the doctor arrives. If the hand has been burned, plunge it in water and keep it there, even for hours until the pain lessens.

When something gets into the eye.—The first thing we usually think of doing when a cinder or an insect gets into the eye is to begin rubbing it. This is the very worst thing that could be done; for rubbing will irritate the tender lining of the lid, and may make the particle imbed itself still more deeply.

The skin of the eyelid may be caught between the finger and the thumb and the lid pulled downward or away from the eye and allowed to snap gently back. This will sometimes loosen the stray particle and then the tears will wash it out.

The corner of a handkerchief moistened in clean water may be used without injury to wipe the particle

out. If this does not work, it is best to sit down in a chair and allow some one standing behind us to turn the lid back so that the particle can be found and removed.

When poison has been swallowed.—In the case of most poisons, the necessary thing to do is to produce vomiting so as to remove the poison from the stomach. A good emetic is mustard mixed with warm water, a teaspoonful to the pint. If mustard is not at hand put salt in the water. If neither can be had do not wait to send or hunt for them, but give the patient warm water. Be sure that he keeps drinking until he vomits. Remember that vomiting is the main thing, and that every second counts. If no warm water is at hand it is even well to give a drink of cold water while water is being warmed. Tickling the back of the mouth with the tip of the finger will help to produce vomiting.

The whites of eggs are safe to give in any kind of poisoning. The whites of four or five, or even six, eggs may be stirred into a quart of water and the person made to drink as much of this as he can.

If an *alkali* or an *acid* poison has been taken, vomiting should not be produced. Alkalies and acids have the power to neutralize, or kill the effects of, each other. A person who has taken an alkali poison, like lye, or ammonia, may be given vinegar, which is acid; one who has taken any acid may be given thick lime water or ordinary baking soda, both of which are alkali.

Common poisons and their treatment.—

Alcohol, whisky	Emetic, strong coffee
Arsenic, rat poison	Emetic, whites of eggs or milk
Gasoline	Emetic
Camphor	Emetic, coffee, warmth
Chloroform	Air, artificial respiration, coffee
Matches	Emetic, whites of eggs, Epsom salts
Morphine, soothing syrup	Emetic, artificial respiration
Turpentine	Emetic, keep awake
Alkalies—	
Ammonia, Lye, Potash	Vinegar, oil, milk
Acids—	
Sulphuric, Hydrochloric	Strong lime water or soda, whites of eggs
Lead poisons	Emetic, Epsom salts
Tobacco	Coffee
Strychnine	Emetic, whites of eggs, artificial respiration
Mushrooms	Emetic, castor oil

Plants that poison the skin.—Many persons are particularly sensitive to poison ivy, which is to be found growing almost everywhere. Of course the safest plan is to keep away from poison ivy; but many persons can not tell the difference between pcison ivy and the harmless kind. Poison ivy has *three leaves* and *yellowish green berries*. The harmless kinds have *five leaves* and *red berries*.

The best remedy so far known for curing poison ivy trouble is simply to wash the skin thoroughly with soap and water. This is a safe thing to do whenever we come in from the woods, and is likely to save us much trouble if our skin is sensitive to plant poisons.

Swamp sumach is a poisonous plant found in thickets in many parts of the United States. It contains the same poison as that found in poison ivy, but the poison is stronger and more severe in its effects. The soap and water treatment is the best remedy. The poisonous swamp sumach has *white berries*, the common, harmless sumach has *red berries*.

Poisonous stings.—The sting of bees, wasps, yellow-jackets, hornets, and even of mosquitoes contains poison. The poison is driven into the skin by means of a sharp stinger. The stinger of the bee is barbed so that he can not pull it out, and so when he stings you he loses his stinger. The stinger should be removed with a pair of tweezers.

The sting of such insects is acid and so calls for an alkali in treatment. Common cooking soda is good for the sting of nearly all insects. If this is not available, a little moistened earth placed over the sting will usually cure the pain.

Bleeding at the nose.—Bleeding at the nose will ordinarily check itself in a few minutes. Keep the head erect, as this permits less blood to be sent to the

nose. Ice, or cloths wrung out of cold water, may be placed at the back of the neck and over the head at the bridge of the nose. Pinching the nostrils together tightly will help hold the blood back until the bleeding naturally stops.

When bleeding of the nose continues for a long time, the doctor sometimes packs the nostril tight with cotton. One should not blow the nose nor cough when the nose is bleeding, as this makes the blood flow faster.

Bandaging.—Bandaging is often necessary to protect a wound from dirt or from injury. Sprains and bruises should be bandaged to protect the injured part and to keep the blood from settling in the broken capillaries.

The *roller* bandage is commonly used by physicians and nurses where the bandaging must be tight. This form of bandage is rather hard to apply, and requires a long strip of cloth rolled up in a firm roll.

The *triangular* bandage is made by cutting diagonally a square piece of white cloth. Cheesecloth makes excellent bandages. The size of the bandage depends on where it is to be applied. Before applying a bandage to a cut or break in the skin the cloth should, if possible, be sterilized by wringing it out of boiling water or by baking it in a hot oven. Bandages should be tied with a "square" knot, as this will not slip and is easily untied.

For small cuts and wounds, torn nails and the like, *surgeon's plaster*, or adhesive tape, should be used. A small piece of sterilized cloth may first be put over a sore, and the cloth held in place by the plaster. Ten-cent rolls of surgeon's plaster can be bought at drug stores.

Interesting things to do.—1. Use a classmate as a patient and show how to start artificial respiration in a person rescued from drowning.

2. Prepare a ring seat and a blanket seat and then show how to carry an injured comrade. Also show how to make a stretcher out of two poles and a blanket, or with the poles and coats. Have some one time the different members of the class to see who can prepare each of these pieces of apparatus in the shortest time.
3. Imagine that your own clothing has caught fire, and show how to proceed in putting it out. Imagine a companion's clothing is on fire and show how to proceed.
4. Show how to remove a cinder from your eye, (1) by pulling down the lid and letting it go, (2) by using the corner of your handkerchief before a mirror.
5. Study the square knot and learn to tie it quickly. Then show how to prepare and apply a bandage to the hand; to the head; to the foot; how to make and apply a sling for the arm.

Questions to answer.—Why should boys and girls learn how to swim? What is the condition of the lungs and heart of a person rescued from drowning? Give full directions for bringing about artificial respiration. What care should be given a person rescued from the water after breathing begins? Explain several different ways in which an injured person may be carried. Tell what to do when the clothing has taken fire. Give directions for removing a cinder from the eye. Give the treatment for each of several different kinds of poison. What is the treatment for poison? What is the treatment for poison ivy or other poisonous plants? Tell how to treat the sting of a poisonous insect. What are the two kinds of bandages most used? Tell how to prepare and apply the different bandages.

Health Problems

1. Give an account of the most exciting or the most serious emergency you were ever in. Did you and did others do the right thing?
2. Gather examples of emergencies in which the wrong thing was done, or in which no one seemed to know what to do. Decide in each case what should have been done.
3. Sometimes in an accident, one must act "without waiting to think." How can he prepare for this kind of action and be sure he will do the right thing?

CHAPTER XLI

SAFETY FIRST

No one likes the coward. Every boy and girl wants to be brave, and to have the spirit of daring and adventure. We should even be willing to show our courage by taking risks for others in times of danger.

But one should never be fool-hardy nor take unnecessary risks. The truly brave man risks danger or death only when he can gain some necessary end by it. The one who risks danger just to show his daring is either vain or he lacks sense and judgment.

Jumping freight trains.—One of the most foolish and unnecessary risks sometimes taken by boys is jumping on moving freight trains or climbing over freight cars in the switching yards.

All railway companies have regulations against persons riding on freight cars or trespassing in the freight yards where cars are being moved. Yet every year there are many tragic accidents because boys disobey these regulations. This morning as I looked out of the window I saw a fine-looking young fellow going down the street with but one leg, a crutch doing duty for the other. Two years ago this boy and three

others undertook to steal a ride on a freight train. An accident happened to Fred, and he will have to go through life a cripple.

Accidents from street-cars.—Every year shows a long list of accidents to people from street-cars. These accidents are mainly from two sources: People are hurt in getting on or off the car, or else they are run over by passing in front of cars. There is just one way of getting on or off a street-car properly. That is, (1) *after the car has stopped;* and (2) with the *face toward* the direction in which the car is moving. If the car suddenly starts this enables one to move forward with its motion in place of falling backward.

Most of the serious street-car accidents, however, come from people being run over by moving cars. This usually happens from some one trying to dodge across ahead of a car, and either misjudging the distance or else being struck by a car coming from the opposite direction on another track. One should never cross a street-car track without *making sure.*

Dodging automobiles.—Nearly every driver of an automobile is very careful not to run over people on the street. Yet occasionally there is a careless driver who disobeys driving regulations, and injures or kills some one in his way.

One should have his best attention about him when he is crossing streets or roadways upon which auto-

mobiles are passing. A large proportion of automobile accidents come from children playing on the streets, and getting so interested in their game that they forget to notice the automobiles.

Only yesterday I saw a driver narrowly avoid running over a small girl by almost driving his car into a street-car. A group of children were playing in the street near the sidewalk when suddenly this girl, looking back at her companions and not pausing to notice whether the street was clear, darted toward the middle of the street and straight into the pathway of the automobile. Her first mistake was playing in the street where automobiles were passing when there were plenty of other places to play. Her second mistake was in running out into the street without first looking to see whether the pathway was clear.

Driving automobiles.—Some states do not permit those under sixteen years of age to drive an automobile, nor allow one to drive without a license showing that he knows how to operate a car. In many places, however, boys and girls much younger than sixteen are found driving cars.

It is no great trouble to learn to drive a car safely if one will have for his rule "safety first" at all times. The collisions and tip-overs and other accidents in which cars are smashed up usually come either from speeding or from disobeying the driving rules.

One who drives an automobile should remember

that he not only has in his keeping his own safety, but also the safety of others who may be driving upon the roadway. No person should drive a car who does not understand his car, and know how to operate it. Nor should he be trusted with a car unless he is willing to drive at reasonable speed, and obey the rules of the road.

Handling firearms.—The paper this morning tells of another shooting tragedy which happened because a boy "didn't know that it was loaded." Every year many people lose their lives by being accidentally shot by those who either do not know how to handle a gun, or else are too careless to be safe in using one.

There are two rules which every person who handles a gun should rigidly follow:

(1) Never point a gun at another person even in fun, though you may be entirely sure that the gun is not loaded.

(2) Always carry a gun with the muzzle pointing forward and downward.

Questions to answer.—Explain the difference between true bravery and foolish daring. What should be the rule about jumping on freight trains, or climbing over cars? Give directions for avoiding accidents by street-cars. Give directions for avoiding accidents by automobiles. What should be our rule in handling firearms? In carrying a gun?

GLOSSARY

KEY TO PRONUNCIATION

a as in fāte, senâte, făt, ärm, all, ȧsk, what, câre.
e " mēte, ĕvent, mĕt, hĕr, thêre, obey.
ee " fēēt.
i " īce, ĭdea, ĭt, sĩr, machĭne.
o " ōld, ōbey, nŏt, move, wolf, sȯn, hôrse, wõrk.
oo " fōōd, fŏŏt.
u " ūse, ūnite, ŭp, fûr, rule, pull.
y " flȳ, mȳself, babȳ, mỹrrh.
au " author.
aw " saw. ew as in new. oi as in boil.
oy " boy. ou " out. ow " cow.

ABDOMEN (ăb dō′mĕn)—The large cavity at the lower part of the trunk which contains the digestive tract and other organs.

AMOEBA (a mē′ba)—An animăl too small to be seen by the eye, and consisting of but a single cell.

ANTISEPTIC (ăn tĭ sĕp′tĭk)—A substance used in wounds and sores for the purpose of killing disease germs.

ANTITOXIN (ăn tĭ tŏk′sĭn)—Any substance that will destroy a disease poison in the body.

ARTHRITIS (är thrī′tĭs)—The scientific name for rheumatism, involving joints.

BACTERIA (băk tē′rĭ a)—Very small, invisible plants consisting of but one cell.

BICEPS (bī′sĕps)—The flexor muscle found at the front of the upper arm.

BRONCHI (brŏn′kī)—The branches of the trachea through which air reaches the air cells of the lungs.

CALORY (kăl′ō rĭ)—The unit for measuring the amount of food the body requires (also a measure for heat).

CAPILLARIES (kăp′ĭ lă rĭz) — Small blood-vessels connecting the arteries and veins.

CARBOHYDRATES (kär bō hī′drāts)—Energy-producing foods.

CARTILAGE (kär′tĭ lāj)—A tough, rubber-like substance found between the bones at movable joints.

CEREBRUM (sĕr′ē brŭm)—The large, upper part of the brain.

CHRONIC (krŏn′ĭk)—Continuing for a long time, as a disease that gradually gets worse.

COAGULATION (kō ăg ū lā′shŭn)—The hardening or clotting of the blood when outside the body.

COCHLEA (kŏk′lē a)—A snailshell-like part of the inner ear.

CORPUSCLES (kôr′pŭs ′lz)—Small bodies found floating in the plasma of the blood.

DIAPHRAGM (dī′a frăm)—The muscular floor or partition between the chest cavity and the abdomen.

DIFFUSION (dĭ fū′zhŭn)—The process by which a liquid or a gas passes through animal tissue.

DYNAMOMETER (dī na mŏm′ē tēr)—An instrument for measuring the strength of the grip of the hand.

EMETIC (ē mĕt′ĭk)—A substance given to produce vomiting.

EPIDEMIC (ĕp ĭ dĕm′ĭk)—An attack of disease which affects a large number of people.

ESOPHAGUS (ē sŏf′a gŭs)—The part of the digestive tract leading from the mouth to the stomach.

FIBRIN (fī′brĭn)—That part of the blood which causes thickening or clotting of blood when outside the body.

FORMALIN (fôr′ma lĭn)—A strong poison used to destroy disease germs or other microbes.

GERMICIDE (jûr′mĭ sīd)—Any substance used to kill germs.

GOITER (goĭ′ter)—A disease which causes an enlargement of the thyroid gland.

INFECTION (ĭn fĕk′shŭn)—Any substance or poison which will cause or communicate disease; or the state of being diseased.

LYMPHATICS (lĭm făt′ĭks)—The system of vessels which convey the lymph in its circulation.

MASSAGE (ma säzh′)—A method of treating the flesh by rubbing, stroking, kneading, etc.

MENINGITIS (mĕn ĭn jī′tĭs)—A serious disease which attacks the wrapping coats of the brain and spinal cord.

MICROBES (mī′krōbs)—Very small animals or plants consisting of a single cell.

MOLECULE (mŏl′ē kūl)—One of the smallest divisions of matter.

NARCOTIC (när kŏt'ĭk)—A drug which stupefies or quiets the nerves and the mind.

NICOTINE (nĭk'ō tĭn)—A poison found in tobacco.

PASTEURIZE (pȧs'tẽr īz)—The process of killing bacteria in milk by heating it just enough to kill the disease germs.

PERICARDIUM (pĕr ĭ kär dĭ ŭm)—The sack or bag which surrounds the heart.

PERIOSTEUM (pĕr ĭ ŏs tē ŭm)—A tissue which covers the bones.

PLASMA (plăz'mạ)—The liquid part of the blood.

PLEURA (plōō'ra)—The wrapping or covering of the lungs.

PROTEIN (prō'tē ĭn)—The part of our foods which goes to rebuild or cause the growth of cells.

PROTOPLASM (prō'tō plăzm)—The living substance of which the body's cells are chiefly composed.

PROTOZOA (prō tō zō'a)—Very small one-celled animals.

PYLORUS (pĭ lō'rŭs)—A muscular gateway between the stomach and the small intestine.

RESPIRATION (rĕs pĭ rā'shŭn)—The process of breathing.

RETINA (rĕt'ĭ na)—The sensitive nerve coat at the back of the eye.

SALIVARY GLANDS (săl'ĭ vā rĭ)—Glands located in each jaw, and which supply the saliva.

SPIROMETER (spī rŏm'ē tẽr)—An instrument for measuring the air capacity of the lungs.

STERILIZE (stĕr'ĭ līz)—To treat in such a way as to kill the germs on any article or in a wound or sore.

TENDONS (tĕn'dŭnz)—Inelastic cords which tie the muscles to the bones.

THORAX (thō'răks)—The upper part of the chest cavity which contains the heart and the lungs.

THYMUS (thī'mŭs)—A gland located behind the breast bone.

THYROID (thī'roid)—A gland located in the throat.

TUBERCLE BACILLUS (tū'bẽr kl bȧ sĭl'ŭs)—The germ which causes tuberculosis.

VACCINE (văk'sĭn)—The matter, or virus, used to vaccinate for smallpox; also dead bodies of germs of certain diseases, injected to immunize the person against that disease.

VILLI (vĭl'ī)—Small, hair-like projections lining the air-passages and acting to expel dust or other foreign particles.

VITAMINS (vī'ta mĭnz)—Substances found in uncooked foods, and necessary to health.

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